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Michigan's Forests 1993: An Analysis

Thomas L. Schmidt, John S. Spencer, Jr., and Robin Bertsch

This report includes the most commonly used U.S. Department of Agriculture, Forest Service, Forest Inventory and Analysis (FIA) statistics. Additional forest resource data can be obtained from FIA staff located in St. Paul, Minnesota, an FIA CD-rom disc, or a table generator available on the North Central Forest Experiment Station's Internet page. Persons requesting additional information from the FIA staff are expected to pay the retrieval costs. Requests for information may be directed to:

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Foreword

FIA is a continuing endeavor as mandated by the Renewable Resources Research Act of 1978. Prior inventories were mandated by the McSweeney-McNary Forest Research Act of 1928. The objective of FIA is to periodically inventory the Nation's forest land. Up-to-date resource information is essential to frame forest policies and programs. USDA Forest Service regional experiment stations are responsible for conducting these inventories.

Fieldwork for the fifth forest inventory of Michigan was begun in April of 1991 and completed in August of 1993. Aerial photographs used were taken in 1986 for the Upper Peninsula, in 1987 for the Northern Lower Peninsula, and in 1988 for the Southern Lower Peninsula. More accurate survey information was obtained during this survey than otherwise would have been feasible because of intensified field sampling. Sampling intensity was increased to a triple intensity level in the Upper Peninsula and to a double intensity level in the Northern Lower Peninsula. Such sampling was made possible through the cooperation, assistance, and additional funding provided by the State of Michigan and Michigan forest industries and associations.

The fifth inventory of Michigan was directed by Neal Kingsley, FIA Program Manager. Robin Bertsch, Forest Development Executive for the Michigan Department of Natural Resources (MiDNR) Forest Management Division, was responsible for all State contacts and activities during the inventory process. FIA staff involved in this inventory effort included: Rose Berg, Beth Collins, John DuPlissis, Barb Freund, Dan Goodman, Dale Gormanson, Ron Hackett, Mark Hansen, Mary Jean Hanson, David Haugen, Barb Knight, Earl Leatherberry, Dennis May, Pat Miles, Jerry Ostrom, Gerhard Raile, Mary Jo Resendez, Jay Solomakos, Mark Springen, and Dan Wendt. FIA Field Crew Members were: Todd Anderson, Kristen Bailey, John Benaszeski, Michelle Benedict, Avery Beyer, Michael Burns, Charles Butler, Paul Castillo, Jeffrey Cronce, Paul Dashner, Mark Dilley, David Duwe, Jay Flynn, Rodney Fonks, Nathan Goodrich, Kevin Hanstein, Cheri Hartless, Patrick Hartless, Robert Haukereid, Doug Hecker, Glenda Hefty, Thomas Huegerich, Jeffrey Hunteman, Gary Inhelder, Jason Jensen, Nicholas Kestle, Peter Koehler, Kyle Lombard, Mark Majewsky, Melissa Mantel, Richard McDonald, Paul McKenzie, Angela Milford, John Muhich, William Nelson, Eric Oliphant, William Peters, Lawrence Plucinski, Theresa Reilly, Fritz Ritter, Brian Schweiss, Patrick Shinners, Gary Stachowicz, Richard Stanford, James Stelick, Jerry Van Cleve, Monica Van Cleve, Heidi Waymann, Kristen Weber, Linda Weidel, Brad Witkin, Erin Witkin, and Christopher Yonkers.

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Michigan's Forests, 1993: An Analysis

Thomas L. Schmidt, John S. Spencer, Jr., and Robin Bertsch

Michigan's forests are abundant, diverse, healthy, productive, and expanding. These forests make important contributions to the quality of life by providing a wide array of benefits, including wildlife habitat, biological diversity, outdoor recreation, improved air and water quality, and economic resources such as the estimated $12 billion of value added and 200,000 jobs annually supported by forest-based industries/tourism/recreation (Bertsch 1994).

Michigan's forests were inventoried for the fifth time by the USDA Forest Service, North Central Forest Experiment Station's Forest Inventory and Analysis Unit (NCFIA). This most recent inventory is dated, and referred to, as the 1993 inventory. Previous inventories of Michigan's forest lands were conducted in 1935, 1955, 1966, and 1980. NCFIA forest inventories are based on a statistical sample of the overall resource, so the reported figures are estimates. More detailed information was obtained during this inventory than in previous ones because of intensified field sampling made possible through the cooperation and additional funding provided by the State of Michigan and Michigan forest industries and associations.

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Forest inventories of Michigan divide the State into four units (fig. 1), based largely on topography, other physiographic considerations, climatic differences, and differences in land use. Although the data in this report reflect these units, the data may be aggregated in many different ways to provide desired information.

The 1993 Michigan forest resources inventory consisted of classifying almost 200,000 aerial photo plots, measuring about 10,750 ground plots in the field, and modeling more than 7,700 forested field plots that were undisturbed between 1980 and 1993. The reader is cautioned to consult the table of sampling errors when using any data contained in this report.

Figure 1.—*Forest Survey Units, Michigan 1993 inventory.*

HISTORICAL OVERVIEW OF MICHIGAN'S FORESTS

Presettlement Conditions

Michigan's pre-European settlement forests were extensive, covering nearly all of the State's 36 million acre land mass. These forests were estimated to consist of 10 million acres of pine, 9 million acres of northern hardwoods, 5 million acres of oak-hickory, 4.5 million acres of spruce-fir, and 7.5 million acres of lowland hardwoods and softwoods (Michigan Department of Natural Resources 1996).

Natural and human disturbances of the forest occurred during this presettlement period. Fires, started by lightning and native people, altered the forest landscape, producing a dynamic forest. These disturbances created an environment in which a diverse forest of many ages and a variety of plant and animal species existed. The tribes of the Algonquin Native American group, including the Chippewa, Huron, Ottawa, Potawatomi, Miami, and Menominee, inhabited these forested lands.

The presettlement forest of southern Michigan (generally acknowledged as being south of a line drawn from Saginaw to Muskegon) primarily consisted of broadleaf deciduous trees. Oak, maple, hickory, beech, and basswood were predominant on the uplands; numerous species of elm, maple, and ash were present on the lowlands. North of this line, the deciduous tree species often mixed with coniferous tree species on all but the driest, sandy plains or the poorly drained, muck-type soils. The Northern Lower Peninsula's uplands had tree species mixes that included beech, hemlock, white pine, yellow birch, and sugar maple. Pine predominated on sandy sites. The Upper Peninsula's upland sites had a greater abundance of balsam fir, white spruce, yellow birch, and hemlock than in the Northern Lower Peninsula. Tamarack, black spruce and northern white-cedar were the primary tree species present on the poorly drained soils.

Settlement/Post Settlement Conditions

European settlement of the Michigan territory began soon after Etienne Brule's exploration in the early 1600's. The fur trade was associated with this period. The economy gradually shifted to agriculture as settlers established small farms to maintain their families and sustain their rural communities. The late 1800's and early 1900's began another shift of the economy to an urban-industrial complex. These patterns of economic development created significant impacts on the forested landscape, which remain evident today. Initially, forests were cleared to permit farming activities, to provide fuel, and to build and sustain the local rural communities these settlers established. Later, extensive commercial logging of Michigan's forests occurred to support the urban-industrial phase of development. Cities such as Detroit and Chicago relied on the lumber produced from Michigan trees for their very existence.

The forest disturbances associated with this development were harsh (fig. 2). Logging was often followed by human-caused slash-burning fires to make way for agricultural activities and by naturally occurring fires. The practice of using fire to clear land ended in the early 1930's. Unfortunately, many forest soils were marginally productive for farming. As farms were abandoned, natural successional processes were unheeded. The Civilian Conservation Corps helped revitalize some of these lands in the 1930's through its tree planting efforts. Today's forests are a legacy of these past practices. The logged and burned forest acreages have been reforested. The extensive red and white pine acreage of the presettlement forest gave way to early successional tree species such as aspen and birch on the more productive soils, and oak and jack pine on the less productive soils.

Figure 2.—*An example of the "stumplands" that were created from the extensive logging and slash burning in the early 1900's. Today, many of these lands have been re-forested.*

EXTENT OF MICHIGAN'S FORESTS

Michigan's forest land totaled almost 19.3 million acres in 1993, representing 53 percent of the total land area of Michigan. The forest land consisted of 18.6 million acres of timberland, 575 thousand acres of reserved forest land, and 90 thousand acres of other forest land. In addition to the forest land, 1.6 million acres of land had trees present, but not enough to permit classification as forest land. Examples of nonforest land with trees includes windbreaks, wooded strips, cropland with trees, marsh land with trees, and undeveloped urban land with trees.

Area of Timberland Increases

Area of timberland increased in Michigan by more than 1.1 million acres between 1980 and 1993—the first increase since European settlement. More than 90 percent of the increase occurred in the Lower Peninsula. This increase came predominantly from: (1) abandoned cropland and pasture on which trees became established so that the land could be reclassified as forest land; and (2) marginal forest lands, once classified as unproductive (nontimberland), that were reclassified in the 1993 inventory as being productive enough to be timberland.

Area of Timber Plantations Decreases

While the area of timberland increased, the area of timberland in plantations decreased from about 1.2 million acres in 1980 to less than 1.0 million acres in 1993. Michigan has been fortunate, from a reforestation and timber production perspective, to have many acres of tree plantations established (fig. 3). These were established through the Civilian Conservation Corps (CCC) in the 1930's and the Soil Bank Program in the 1950's; through various tree planting incentive programs at the Federal, State, and local level; and by landowners with the forethought and insight to plant trees on marginally productive croplands and pasture lands. These early tree planting efforts are currently providing the benefits that were envisioned by the thousands of people willing to do the arduous, back-breaking task of planting trees. As these plantations mature and are harvested, some are replanted for another rotation of trees, but some are converted to other land uses, which has resulted in the decrease in area of plantations. Tree planting in Michigan continues; in fact, 45 percent of all timberland plantations are less than 30 years old.

Tree plantations in Michigan primarily contain conifers. In 1993, 90 percent of all timberland plantations in Michigan were either red or jack pine. Although tree planting occurs throughout Michigan, the Northern Lower Peninsula Unit accounts for more than 60 percent of all plantations.

Figure 3.—*Timber plantations that are intensively managed are an important source of wood products in Michigan. Plantations like this red pine planting were found to have some of the highest growth rates in the State.*

Reserved Forest Lands

The area of reserved forest land decreased from the previous inventory. In the 1980 inventory, public forest lands being considered for designation as wilderness areas were classified as reserved because NCFIA did not

know the final outcome of that study. Some, but not all, of these acres became wilderness areas and continued to be classified as reserved in the 1993 inventory. As an example, six areas were added to the Hiawatha National Forest as wilderness in 1987. The proposed wilderness areas that were not designated were reclassified as timberland and are the reason the area of reserved forest land decreased between inventories. However, Michigan still maintained a long-term increase in the historical area of reserved forest land. About 575 thousand acres were classified as reserved forest land in 1993, compared to about 311 thousand acres in 1966.

Nonforest Lands With Trees

Many of the additional 1.1 million acres of timberland added between inventories came from nonforest land with trees. For example, the area of nonforest land with trees classified as narrow wooded strips (less than 120 feet in width) decreased from 241 thousand acres to 131 thousand acres from 1980 to 1993. Most of the decrease was due to the narrow wooded strips being reclassified as timberland because they increased in width between inventories. Some classifications of nonforest land with trees increased in area from 1980 to 1993, including marsh land with trees, idle farmland, and windbreaks. One would expect that in the future, barring any major disturbances or land-use changes, some of the areas currently classified as nonforest land with trees would convert to timberland as more trees become established.

Regions Differ in Forested Land Area

The Southern Lower Peninsula Unit had the most land area but the least amount of forest land in 1993. Approximately 20 percent of the Southern Lower Peninsula Unit was classified as forest land. Area of timberland in this Unit increased from about 2.5 million acres in 1980 to more than 3 million acres in 1993 (fig. 4).

The Northern Lower Peninsula Unit was approximately 65 percent forested. Representing almost 40 percent of all forest land in Michigan, this Unit had 7.4 million acres of timberland—an increase from the 7.0 million acres reported for 1980.

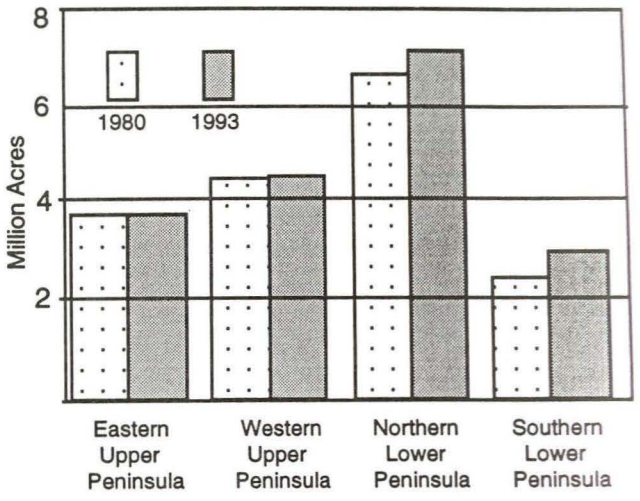

Figure 4.—*Area of timberland by Forest Survey Unit, Michigan, 1980 and 1993.*

The Western Upper Peninsula Unit was the third largest in total land area in 1993, but had the highest percentage of land occupied by forests, with almost 9 out of every 10 acres forested. Marquette County, with more than a million acres of timberland, was the most heavily forested county in the State. Area of timberland in this Unit increased by 3 percent from 1980 to 1993, gaining 33 thousand acres.

The Eastern Upper Peninsula Unit was the smallest in land area, but 80 percent of the land in this Unit was forested. There were minor fluctuations in the Eastern Upper Peninsula between area of timberland, reserved forest land, and other forest land, but in general, the forest resource base was stable with little change over time in the total number of forested acres.

COMPOSITION OF MICHIGAN'S FORESTS

Michigan's forests are composed of a wide variety of trees, shrubs, and understory vegetation. All the trees found in Michigan's forests are grouped or classified into forest types that reflect the combinations of species that occur. The distribution of trees is based on site characteristics, past history, and climate. Each of these factors influences what vegetation is currently found on the site and what vegetation is potentially able to exist there. As an example, swamp conifers primarily grow on areas with wet, poorly drained soils. However, past logging, drainage efforts,

or fires have influenced what species currently exist on such soils. One swamp conifer site might be typed as a black spruce forest and another may be typed as northern white-cedar. Both sites might have had the potential to be either forest type, but due to previous influences each evolved into different forest types. Forest types in Michigan range from early successional types, such as aspen and jack pine, to late successional types such as maple-beech-birch and oak-hickory. In 1993, there were eight conifer dominated forest types and six hardwood forest types.

Forest Types in Michigan

Between 1980 and 1993, the area classed as aspen, jack pine, paper birch, balsam fir, and balsam poplar forest types decreased. The declining area of these species reflects in part a maturing of Michigan's forest resource, improved fire protection, and changing management practices. Of the early successional forest types, aspen decreased the most. While early successional forest types were decreasing, later successional forest types such as white pine, oak-hickory, and maple-beech-birch were increasing.

Michigan's forest composition has shifted rather dramatically over time. Table A shows the FIA-determined land classification changes from 1980 to 1993. To use table A—for example to find out what happened to the 588.2 thousand acres of red pine present in 1980—simply read across the red pine row and find that 558.3 thousand acres remained as red pine, 2.3 thousand acres converted to white pine, 20.3 thousand acres converted to oak-hickory, and so on. To determine the source of the 897.2 thousand acres of red pine present in the 1993 inventory, read down the red pine column. Of these acres, 558.3 thousand acres were previously red pine, 78.4 thousand acres converted from jack pine to red pine, 7.6 thousand acres converted from white pine to red pine, and so on.

Hardwood forest types accounted for 75 percent of the timberland area in Michigan. In 1993, there were about 13.9 million acres of hardwood forest types, an increase of about 830 thousand acres since 1980. Softwood forest types accounted for 25 percent of the timberland area. Michigan has three major groups of softwood forest types: the pines which include jack, red, and white pine; swamp conifers which include northern white-cedar, black spruce, and tamarack; and the balsam fir/white spruce group.

Maple-beech-birch is the most extensive forest type

In 1993, maple-beech-birch was the most extensive forest type with more than 7.1 million acres of timberland statewide, an increase of 0.9 million acres since 1980 (fig. 5). This was the largest increase in area for any of the 14 different forest types found in Michigan. The predominant tree species in this forest type are sugar maple, yellow birch, basswood, and beech, all of which are shade-tolerant. As Michigan's forests continue to mature, this forest type is expected to continue to expand in area.

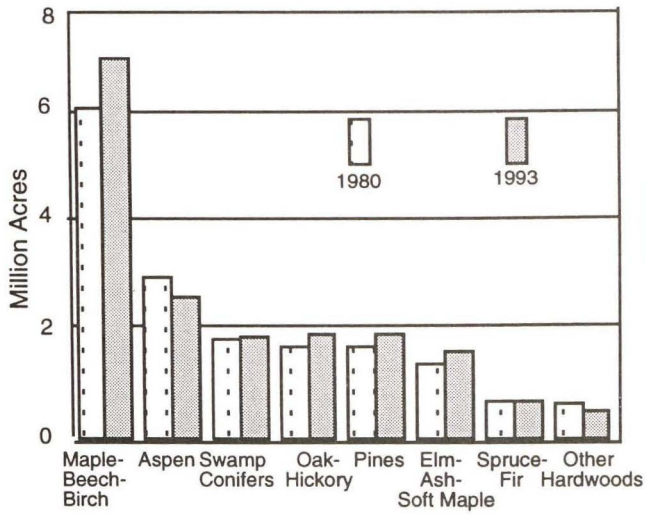

Figure 5.—*Area of timberland by forest type group, Michigan, 1980 and 1993.*

Table A. Land-use classification changes in Michigan, 1980-1993

		1993 Land Classification [1]																			
		Timberland - forest type																			
Previous use	1980 area [2]	Jack pine	Red pine	White pine	Balsam fir	White spruce	Black spruce	Northern white-cedar	Tamarack	Oak-hickory	Elm-ash soft maple	Maple-beech-birch	Aspen	Paper birch	Balsam poplar	Non-stocked	Other forest land	Reserved timberland	Wooded strips	Other nonforest with trees	Nonforest without trees	Census water
Timberland		(Thousand acres)																			
Jack pine	964.2	718.4	78.4	26.3	11.4	-	3.4	-	-	65.4	2.6	13.9	19.7	-	-	12.6	-	2.4	-	6.3	3.4	-
Red pine	588.2	-	558.3	2.3	-	-	-	-	-	20.3	-	-	3.2	-	-	-	-	2.3	-	-	1.8	-
White pine	199.4	-	7.6	130.1	6.3	-	6.9	1.3	-	-	8.8	25.6	8.3	-	-	-	-	1.5	-	2.6	0.4	-
Balsam fir	576.8	-	3.2	-	275.8	28.2	32.8	19.3	4.5	13.8	48.0	44.3	57.5	1.5	16.1	-	-	13.7	-	11.4	6.7	-
White spruce	140.2	7.5	-	1.2	27.8	62.9	1.7	3.1	-	-	1.3	8.5	22.7	3.5	-	-	-	-	-	-	-	-
Black spruce	450.3	1.7	3.8	-	25.3	3.1	356.9	12.9	4.2	-	8.8	2.2	9.5	6.5	8.4	-	5.5	-	-	1.5	-	-
Northern white-cedar	1,292.6	-	-	-	30.9	-	18.1	1,098.9	18.9	-	29.9	1.9	32.8	5.3	14.3	1.6	10.1	26.9	-	1.7	1.6	-
Tamarack	121.6	-	-	-	3.8	-	5.7	6.3	96.1	-	0.8	-	1.1	-	-	-	2.7	-	-	5.1	-	-
Oak-hickory	1,768.4	39.5	53.5	-	-	-	-	2.1	-	1,431.2	19.8	139.7	61.6	-	-	-	1.9	3.0	-	9.1	7.0	-
Elm-ash-soft maple	1,422.1	-	-	-	18.4	9.3	1.9	16.1	1.7	9.9	962.5	337.3	26.8	-	8.1	-	9.8	13.1	-	4.6	2.6	-
Maple-beech-birch	6,218.7	20.7	59.9	24.7	60.5	3.7	3.7	5.4	-	133.1	217.8	5,438.6	169.5	14.9	-	-	1.7	34.2	-	12.9	17.4	-
Aspen	3,082.3	19.9	36.5	15.8	38.1	12.6	-	22.7	-	134.5	188.2	539.5	1,981.3	39.9	12.9	2.4	2.0	15.6	1.5	11.4	7.5	-
Paper birch	368.4	-	9.2	-	41.5	-	-	18.9	3.2	11.8	4.8	69.7	67.6	125.3	3.1	-	-	12.2	-	1.1	-	-
Balsam poplar	193.2	-	1.8	-	1.7	4.1	-	3.6	-	-	32.7	32.2	6.6	-	108.7	-	-	-	-	1.8	-	-
Nonstocked	86.2	12.2	5.1	-	8.8	-	-	-	-	8.1	5.6	10.4	4.0	21.2	-	-	4.7	-	-	4.9	1.2	-
Other forest land	194.3	5.2	-	2.9	1.3	-	17.4	30.5	5.6	5.4	10.4	2.8	-	11.7	2.0	-	48.0	1.6	-	45.3	4.2	-
Reserved forest land	680.9	1.2	4.7	2.0	-	2.4	-	21.7	-	48.1	6.7	28.7	9.2	2.5	-	-	-	393.0	-	45.0	99.8	15.9
Wooded strips	252.2	-	2.2	6.6	-	-	-	6.7	-	12.8	16.4	17.7	6.7	-	-	-	-	-	19.9	51.8	110.0	1.4
Nonforest with trees	512.5	11.2	24.5	6.7	2.7	4.0	7.0	62.3	-	29.3	22.6	88.9	37.1	22.8	1.9	-	3.8	4.4	2.3	114.6	66.4	-
Nonforest without trees	16,251.6	8.6	48.5	15.2	8.8	16.6	9.6	17.6	14.7	58.1	39.2	359.4	150.5	36.4	14.2	21.9	-	50.8	19.0	1,250.6	13,986.0	125.9
Census water	806.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.4	8.9	794.7
Total	36,125.1	846.1	897.2	233.8	563.1	146.9	465.1	1,349.4	148.9	1,981.8	1,626.9	7,161.3	2,675.7	291.5	189.7	38.5	90.2	574.7	42.7	1,584.1	15,450.6	937.9

(1) Read across rows to determine dispersion of 1980 classes to 1993 classes. Read down columns to determine origin of 1993 classes.

(2) Total land area adjusted to conform to 1980 census figures.

Aspen has an interesting history in Michigan

By most accounts, Michigan's area of aspen was small prior to European settlement. The limited forest area burned and cleared by Native Americans did not permit large areas of aspen to regenerate. Natural disturbances such as wind storms and lightning-caused wildfires resulted in clearings and opportunities for re-establishment of forested areas, but, these disturbances were generally not great enough to result in large areas of aspen. After Europeans settled Michigan, aspen proliferated from the large areas of disturbed land cleared for farming and other non-forest uses. This time period represents the most significant disturbance period in recent history that significantly impacted the current forest types, such as aspen, found in Michigan.

There were about 3.8 million acres of aspen timberland in Michigan in 1935 (Findell *et al.* 1960). While many areas of aspen were converting to other forest types during the mid-1900's, aspen was also invading cutover areas of pine and fir as well as abandoned farmland. In 1955, one-half the total area of aspen in the Lake States showed a tendency to convert to other species. Thus, while the total area of aspen stayed about the same between 1935 and 1955, hundreds of thousands of acres were moving into or out of the aspen forest type classification. By 1966, the area of aspen had grown to more than 4.2 million acres, the peak in area of aspen for Michigan. Between 1966 and 1993, the area of forest land classified as aspen forest type declined to 2.7 million acres. This decline was the result of continuing forest succession as the shorter lived aspen was replaced in stands by more shade-tolerant understory species such as maple, beech, and yellow birch.

Based on this historical trend, one could predict that the area of aspen will continue to decline. However, the current demand for aspen from Michigan's forest industries is at a historical high. If maintaining aspen is important for Michigan, management will have to be directed toward re-establishing this forest type. The aspen forest type provides many economic and environmental benefits. For example, ruffed grouse prefer aspen stands as habitat. To maintain the State's population of ruffed grouse, forest management will have to consider means of maintaining aspen (fig. 6).

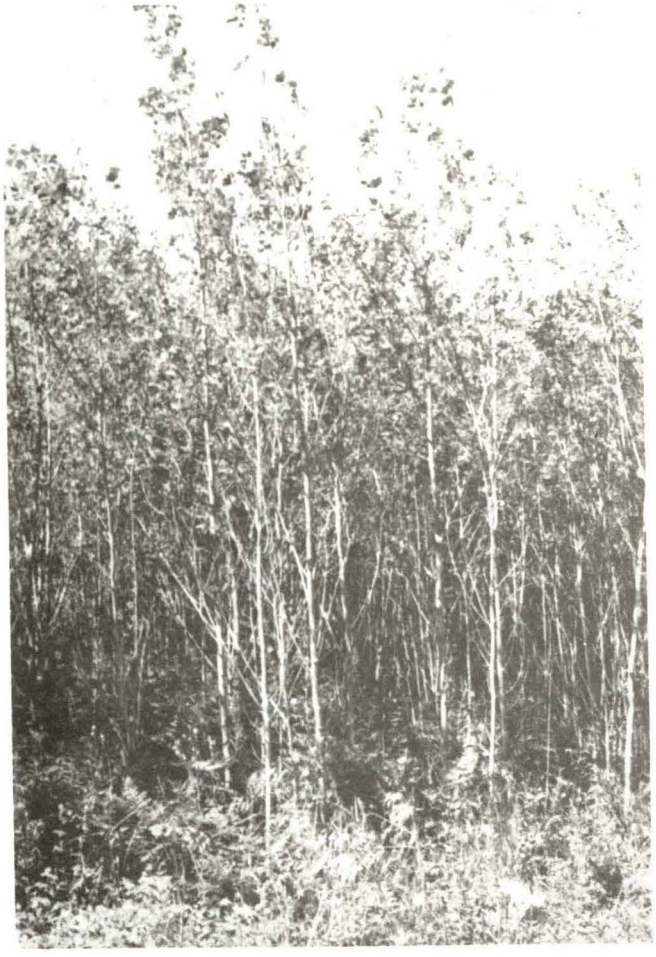

Figure 6.—*This dense aspen sapling stand in the Upper Peninsula is representative of most young aspen stands in Michigan. Young stands of aspen provide excellent habitat for many woodland-dependent wildlife species such as ruffed grouse.*

Other hardwood forest types increase

While the maple-beech-birch forest type was perhaps the most volatile in terms of changes in classification during the 13 years between inventories, many forest types also showed considerable change. The oak-hickory and elm-ash-soft maple forest types both increased by more than 200 thousand acres from 1980 to 1993, with 90 percent of the increase occurring in the Lower Peninsula.

Conifers continue to increase in Michigan

There were about 4.7 million acres of conifer forest types in 1993, an increase of almost 320 thousand acres from 1980. This represented an average increase of about 25 thousand

acres each year. All softwood forest types, except for jack pine and balsam fir, increased in area between 1980 and 1993. Michigan had about 2 million acres of pines in 1993 compared to 1.8 million acres in 1980, about 710 thousand acres of balsam fir-white spruce in both inventories, and about 2 million acres of swamp conifers in 1993 compared to 1.9 million acres in 1980.

Pine forest types

Red pine increased by more than 300 thousand acres, with most of the increase coming from acres of jack pine forest type being reclassified as red pine. The jack pine forest type decreased by about 118 thousand acres. Both red and jack pine usually establish themselves in almost pure stands, primarily due to their need for bare soil in which to germinate. The result is generally an even-aged stand that shades out understory species. For example, more than 80 percent of the total red and jack pine growing-stock volume in Michigan was in the red and jack pine forest types in 1993.

White pine, while it often establishes itself in almost pure stands, can also be found mixed with other conifer and deciduous species. Other forest types, such as maple-beech-birch and oak-hickory, contain significant numbers of white pine trees. The white pine forest type increased by 17 percent (more than 34 thousand acres) between 1980 and 1993. However, white pine growing-stock volume increased by 45 percent during this same time period. Only 27 percent of the total white pine growing-stock volume in 1993 was in the white pine forest type.

Nonstocked timberland declines

Nonstocked timberland declined between inventories. Nonstocked timberland is forest land that is not developed for nonforest use and that currently does not have enough live trees established to meet the minimum stocking requirements. Michigan's "stumplands," a remnant of early logging, were a major component of the State's forest resources in the early 1900's. Since the first inventory conducted in the mid-1930's, the area of nonstocked timberland has continued to decrease, primarily due to improved land management, fire protection, natural reversion, and tree planting. In 1993, nonstocked timberland accounted for less than 0.2 percent of the total area of timberland.

Michigan's Timberlands Are Productive

The productivity of Michigan's timberland is evaluated through measures of potential wood productivity and/or site index class. Potential productivity is an estimate of the cubic feet of growth per acre per year at culmination of mean annual increment of a fully stocked natural stand. Although this definition is intended for industrial wood production, it is a good measure of the potential for a forest to produce a wide array of products/benefits.

Twenty-nine percent of Michigan's timberland had a potential productivity of more than 85 cubic feet per acre per year in 1993, above average for the Lake States. The level of potential productivity increases as one moves south in the State. Only 16 percent of the timberland in the Eastern Upper Peninsula Unit and 22 percent of the Western Upper Peninsula Unit had a potential productivity of more than 85 cubic feet per acre per year. Thirty percent of the timberland in the Northern Lower Peninsula Unit and 52 percent of the timberland in the Southern Lower Peninsula Unit had a potential productivity of more than 85 cubic feet of growth per acre per year. The Southern Lower Peninsula Unit contained more than 60 percent of all of the timberland with the greatest potential productivity (more than 165 cubic feet of growth per acre per year). This is an indication of the more productive soils, longer growing season, and fewer site restrictions (such as wetness) associated with the southern portions of the State.

Site index is another measure of productivity for Michigan's timberlands. Site index is an expression of forest site quality based on the average height of free-growing dominant or co-dominant trees of representative species in the forest type at age 50. In general, good productivity is expected on sites with a site index of more than 50. In 1993, 80 percent of Michigan's timberland was rated as having a site index of more than 50. Excellent productivity is expected on sites with a site index of more than 80. In 1993, 13 percent of all of the timberland in Michigan had a site index of more than 80. In the Lake States, Michigan has the highest percentage of what is generally considered excellent productivity sites.

On a unit basis, the Eastern Upper Peninsula Unit had only 3 percent of its timberland with a site index of more than 80. This reflects the lower site productivity associated with poorer sites such as swamp conifers commonly found in this Unit. Seven percent of the total timberland area in the Western Upper Peninsula Unit, and 13 percent in the Northern Lower Peninsula Unit were rated as having a site index of more than 80. The Southern Lower Peninsula Unit had 38 percent of its timberland with a site index of more than 80. This high index again reflects the excellent growth potential for timberland in this portion of Michigan.

Stocking of Michigan's timberlands can be improved

Based on the potential productivity and site index measures, it should be understood that Michigan has highly productive timberlands that have the capability of producing a wide variety of forest-related products at an above average rate (fig. 7). But to do so, the timberlands must be well-stocked. Stocking is a measure of how occupied the land is by trees and is typically measured by basal area (the area, in square feet, of the cross section at 4.5 feet of all of the trees in a stand, usually expressed as square feet per acre). Full stocking is the goal for most forest managers.

In 1993, about 8.3 million acres of Michigan's timberland were fully stocked. With less than 45 percent of the timberland in a fully stocked state, a number of opportunities exist in the State. Improving the stocking level on understocked timberland would provide many opportunities for increasing the productivity of the forest resource without impacting other land uses. Although the area of timberland is increasing at the current time, it probably will not continue in the long term due to ever increasing pressures for conversion to other land uses. However, forest productivity can still be increased through improved stocking on more than a million acres of timberland.

Another management opportunity exists for Michigan in overstocked timberlands. As the State's timberlands continue to mature, their stocking level will continue to increase as evidenced by what has occurred with the area of overstocked timberland. In 1993, there were 5 million overstocked acres compared to 1.5 million acres in 1980. This tremendous increase in only 13 years reflects the continuing growth in diameter and height of the maturing forest resource that was established in the early- to mid-1900's.

Figure 7.—*There are many management opportunities for Michigan's northern hardwood stands. Proper management can improve the production of wood fiber as well as increase the quality of other forest-related products such as recreation, as shown in this photo of a productive hardwood stand that also provides an excellent hiking trail.*

Size Class

As expected with a maturing forest, the average stand size of Michigan's timberlands is increasing (fig. 8). Stand size reflects the average diameter of the dominant trees and is classified as either sawtimber, poletimber, or sapling/seedling. Sapling/seedling stand size generally represents a young, recently established stand. In the case of swamp conifers, with their associated slow growth rates and poor site conditions, some older, more mature

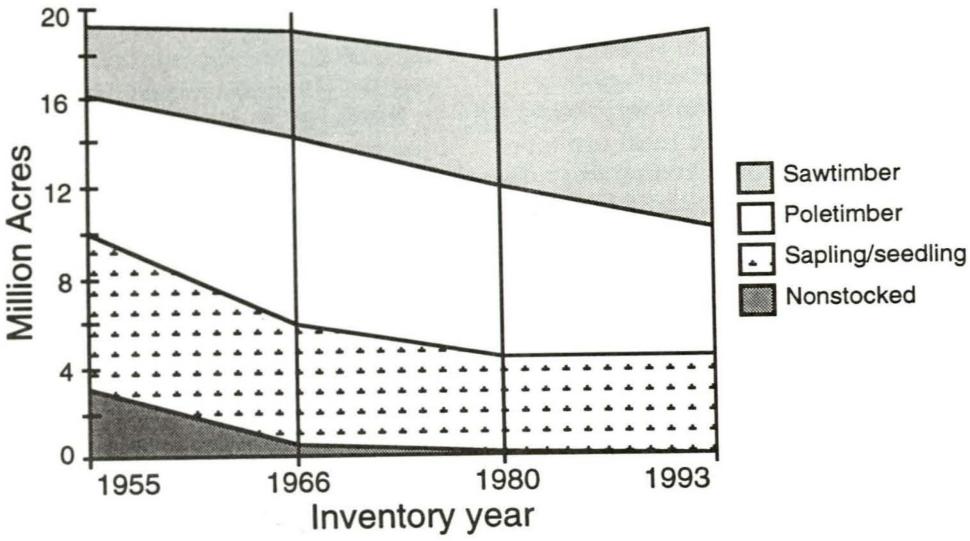

Figure 8.—*Timberland area by stand-size class from Michigan forest inventories, 1955 to 1993.*

stands are classified as sapling/seedling. The dominant trees in this stand-size class are less than 5 inches d.b.h. The area of forest land in Michigan in the sapling/seedling stand-size class, about 4.4 million acres, remained relatively constant between 1980 and 1993. Many of the forest land acres that were in this size class in 1980 grew into the poletimber stand-size class in 1993. At the same time, many of the sawtimber stands from 1980 were disturbed, losing their overstory of larger trees, and were reclassified as sapling/seedling stand.

Area of Poletimber Declines Dramatically

The area of poletimber size stands decreased significantly between 1980 and 1993—from 7.5 million acres to 5.5 million acres. In 1980, poletimber stands were the dominant size class in Michigan with more than 44 percent of all timberlands in this classification. By 1993, poletimber stands accounted for only 30 percent of Michigan's timberlands. Most of this change occurred as poletimber-sized stands grew in diameter and thus were classified as sawtimber stands in the most recent inventory.

The area of sawtimber-sized stands increased by 55 percent, gaining 3.1 million acres between 1980 and 1993. By 1993, sawtimber stands represented 46 percent of all timberland in Michigan. All of the conifer forest types increased in area of sawtimber from 1980 to 1993. Red pine showed one of the most dramatic increases in area of sawtimber. In 1980, an estimated 140 thousand acres of red pine were classified as sawtimber. In 1993, more than 430 thousand acres of red pine timberland were sawtimber. This increase came from red pine stands continuing to mature as well as other forest types, primarily jack pine stands. Jack pine tends to die out before red pine in a mixed stand due to its shorter life expectancy. As the numbers of jack pine decrease, the stand becomes dominated by red pine and is reclassified to the red pine forest type.

All of the hardwood forest types increased in area of sawtimber and decreased in area of poletimber from 1980 to 1993. In addition, all of the hardwood forest types, except for maple-beech-birch, decreased in area of sapling/seedling sized stands. The increases in area of sawtimber by forest type were dramatic; for example, oak-hickory increased by 80 percent, elm-ash-soft maple increased by 67 percent, and aspen by 72 percent from 1980 to 1993.

As Michigan's timberlands continue to mature, the area classified as sawtimber will continue to increase at the expense of the poletimber and sapling/seedling stand-size classes (fig. 9). Presently, this offers many excellent opportunities for management on these timberlands. Having an economically viable product (like

sawtimber) available to cover annual costs of ownership greatly enhances the probability of management occurring. The occurrence of vegetative management activities, such as tree harvesting, helps to ensure that the next generation of trees becomes established for the long-term health and productivity of Michigan's forests.

Figure 9.—*Sawtimber-sized stands are dominated by larger trees, but they typically also contain many smaller trees. This photo in Newaygo County shows the wide range of tree sizes found in most hardwood stands.*

Largest Area in Stands 41 to 60 Years Old

More than 22 percent of all timberlands in Michigan were in the 41- to 60-year stand-age class. Michigan had an excellent distribution of stand ages in 1993: 35 percent of its timberland had an average stand-age of less than 40 years old, 41 percent had an average stand-age of between 40 and 80, and 24 percent were more than 80 years in age (fig. 10). As of the 1993 inventory, more than 6 percent of all timberlands in Michigan were more than 120 years in age.

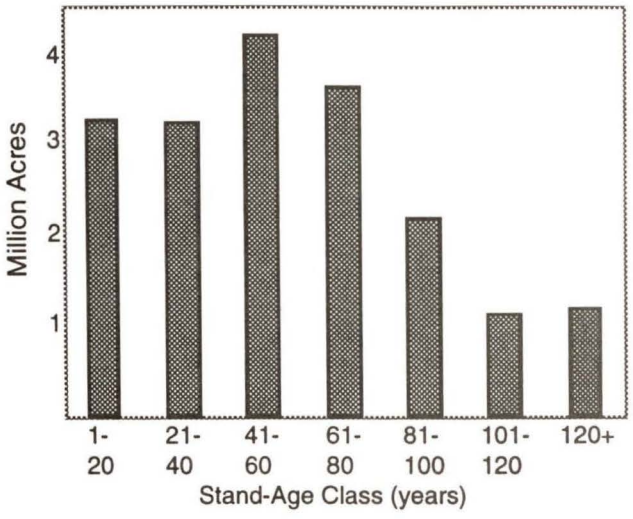

Figure 10.—*Timberland area by stand-age class, Michigan, 1993.*

Ownership of Michigan's Timberlands

65 percent of all timberlands are privately owned

Private landowners owned 65 percent of all timberlands in Michigan in 1993, about 12 million acres (fig. 11). The private sector component is comprised of non-industrial private landowners, Native American tribes, corporations without a primary wood processing facility, and forest industries that have a wood processing facility. The largest sector of private land ownership was non-industrial private individuals with more than 8.4 million acres. This ownership group, with contrasting backgrounds, goals, and management strategies, tends to have smaller tracts. In 1980, 36 percent of the non-industrial private timberlands were in tracts of less than 50 acres. By 1993, more than half of all non-industrial private timberlands were in ownerships of less than 50 acres.

In 1980, 19 percent of the non-industrial private timberland was in ownerships of more than 500 acres compared to only 5 percent in 1993. This trend toward smaller parcels is a reflection of individuals owning forest land for

a wide variety of reasons beyond timber production. As more private individuals own smaller parcels of land, the result is a patchwork of forest conditions, production of goods and services, and forest sustainability. Management of these timberlands for any of the goods and services demanded is more difficult due to the inefficiencies associated with smaller tracts and more diverse ownership goals that complicate the overall effect of an increasing fragmentation of the forest land base. As the average size of holdings by private landowners continues to decrease, forest land managers will have to use practical and effective means in reaching the desired goals.

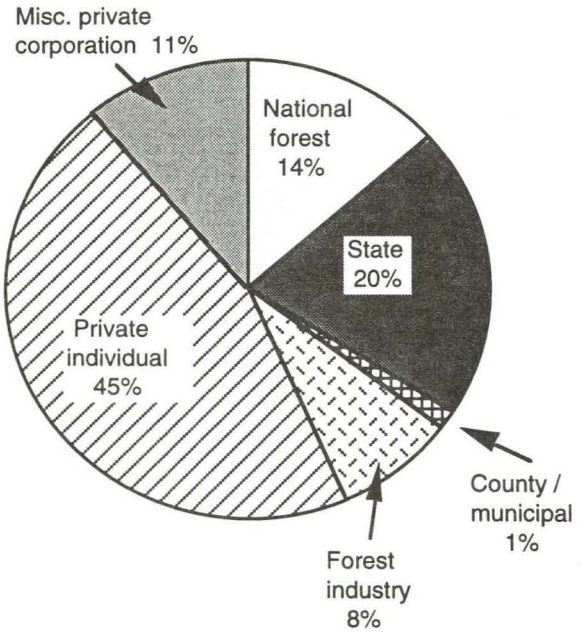

Figure 11.—*Major timberland ownerships, Michigan, 1993.*

Almost all of the forest industry owned timberland is in the Upper Peninsula. In the Western Upper Peninsula Unit, forest industries owned more than a million acres, which represented 24 percent of all timberlands in that Unit. As one moves south in Michigan, the percentage of timberland owned by forest industries decreases and the percentage owned by private individuals increases. In fact, non-industrial private individuals own more than 80 percent of all timberland in the Southern Lower Peninsula.

35 percent of all timberlands are publicly owned

Statewide, the public owns about 35 percent of all timberlands. The largest public owner of timberland is the State of Michigan with 3.7 million acres. In addition, National Forests account for 2.5 million acres and local governments account for 256 thousand acres of timberland. Public ownership of timberlands increases as one moves north in Michigan. In the Southern Lower Peninsula, the public owns 12 percent of the timberland resource, primarily as State ownership. Moving north, public ownership represents 39 percent of the timberlands in the Northern Lower Peninsula, 35 percent in the Western Upper Peninsula, and 46 percent in the Eastern Upper Peninsula.

Conifer timberlands tend to be on public lands

In 1993, 51 percent of all conifer forest types were on public lands. About 64 percent of Michigan's white-red-jack pine timberlands and 41 percent of the spruce-fir forest types were publicly owned. This was disproportionate based on the public owning about 35 percent of the total area of timberland in Michigan. National Forests were the largest owner of red pine; in fact, there were more acres of red pine on National Forests than on all of the private lands combined. The State of Michigan was the largest owner of jack pine and black spruce. Private non-industrial landowners owned the most acreage of white pine, balsam fir, white spruce, northern white-cedar, tamarack, and all of the hardwood forest types.

Number of Trees

In 1993, almost 11.5 billion trees in Michigan were more than 1 inch in d.b.h., of which almost 10.4 billion were growing-stock trees. The 1.1 billion non-growing-stock trees consisted of non-commercial tree species such as hawthorn and striped maple as well as rough and rotten trees of commercial species.

Total number of big trees increases

Although the number of smaller trees decreased, the number of larger trees increased. In 1980, there were 335 million growing-stock

trees between 11 and 21 inches d.b.h. compared to 488 million in 1993. The number of growing-stock trees more than 21 inches d.b.h. almost doubled between inventories. These changes in the number of trees reflect Michigan's maturing forest resource.

Northern white-cedar is a species of concern in Michigan due to a lack of regeneration. Between inventories, there was a decline of more than 145 million northern white-cedar trees less than 5 inches d.b.h. Some of the difficulty in establishing northern white-cedar is due to heavy browsing by unprecedented populations of white-tailed deer. If established, northern white-cedar tends to be able to maintain itself, as shown by the increase in the number of trees in all diameter classes more than 5 inches from 1980 to 1993.

Hard maple followed the same pattern established by red pine and northern white-cedar, decreasing in the number of trees less than 5 inches d.b.h. and increasing in all other diameter classes. The decline in small hard maple trees was dramatic, moving from about 1.4 billion in 1980 to less than 1.0 billion in 1993. Other hardwood species that declined in the total number of trees were select red oak, hickories, basswood, birches, soft maple, elm, black ash, willow, and butternut. Some of these, such as elm and butternut, declined due to pest-related problems while others declined because of a lack of regeneration or harvest.

Volume

Volume increases between inventories

The volume of growing stock increased from almost 20 billion cubic feet in 1980 to nearly 27 billion in 1993, a 35-percent gain (table B). Growing-stock volume is the volume of wood on timberland in growing-stock trees at least 5 inches d.b.h., from 1 foot above the ground to a top diameter of 4 inches d.b.h., less rot or other defects that reduce the yield for forest products. Sawtimber volume increased from about 46 billion board feet (International 1/4-inch rule) to 71 billion between inventories, a 56-percent gain.

Greatest volume in Northern Lower Peninsula

The greatest volume of growing stock was in the Northern Lower Peninsula Unit; its 10 billion cubic feet represented 38 percent of the State total (fig. 12). Although the Southern Lower Peninsula Unit contains the smallest volume of any unit (4+ billion cubic feet), its growing-stock volume increased faster between inventories than that of any other unit (63 percent).

Hardwood volume dominates

Hardwoods account for 72 percent of the growing-stock volume, softwoods account for 28 percent. Hard maple (4 billion cubic feet) and soft maple (3.5 billion) far exceed the 1993

Table B.—*Net volume of growing stock and sawtimber by species group, Michigan, 1980 and 1993*

Species group	Growing stock		Sawtimber	
	1980	1993	1980	1993
	Million cubic feet		*Million board feet*	
Softwoods	5,648	7,572	15,035	22,692
Hardwoods	14,102	19,073	30,514	48,279
Total	19,750	26,645	45,549	70,971

volumes of any other species, and together make up 28 percent of the total for all species (table C). Aspen had the third largest volume in 1993, followed by northern white-cedar, red pine, and select red oaks.

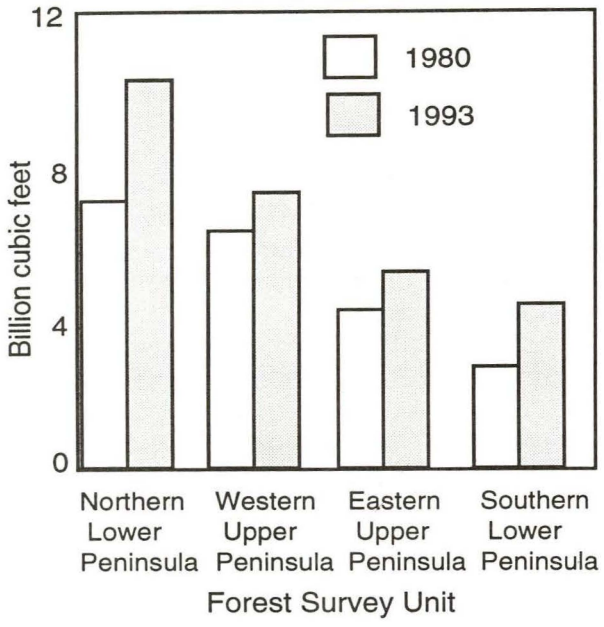

Figure 12.—*Volume of growing stock by Forest Survey Unit, Michigan, 1980 and 1993.*

Sugar maple has been a mainstay of Michigan's forests since the earliest statewide forest inventory. During the 1955 inventory, the growing-stock volume of sugar maple was second to the volume of aspen, but in each successive inventory sugar maple volume was greater than that of any other species. Sugar maple is very tolerant of shade and thrives in the understory of many stands in which less tolerant species cannot survive.

Red maple, also shade-tolerant, is a major component of the elm-ash-red maple forest type. It, too, grows well in the understory of many forest types and is able to use sites that are more moist than those generally used by sugar maple. Red maple is short- to medium-lived, compared with the much longer lived sugar maple. Its aggressive sprouting, tenacity, and early rapid growth have made it a major species in the State and in much of the Northeastern United States in terms of timber volume.

Volume in every diameter class increases

The 8- and 10-inch diameter classes contained the greatest growing-stock volumes in 1993, as they did in 1980 (fig. 13). But the volume

Table C.—*Net volume of growing stock on timberland by selected species groups and percent change between inventories, Michigan, 1980 and 1993*

Species group	1980	1993	Percent change
	Million cubic feet		
Hard maple	2,818	4,043	43
Soft maple	2,350	3,452	47
Aspens	2,622	3,208	22
Northern white-cedar	1,410	1,833	30
Red pine	763	1,627	113
Select red oaks	1,135	1,605	41
Basswood	699	904	29
White pine	599	870	45
Paper birch	803	845	5
Balsam fir	789	823	4
Select white oaks	573	820	43
White and green ash	440	814	85
Hemlock	561	662	18
Jack pine	624	603	(-) 3
Yellow birch	520	498	(-) 4
Black cherry	342	496	45
White spruce	388	494	27
Beech	354	477	35
All other species	1,960	2,571	35
All species	19,750	26,645	35

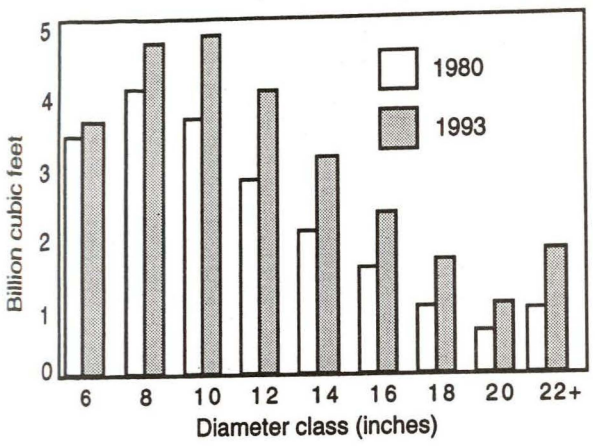

Figure 13.—*Net volume of growing stock on timberland by diameter class, Michigan, 1980 and 1993.*

in every diameter class increased between inventories. The largest diameter classes had the greatest proportional volume increases.

Compared to hardwood volume, a larger proportion of softwood volume was in small diameter trees. For example, the 6- and 8-inch classes contained 43 percent of the total softwood volume, but the same classes contained only 26 percent of the hardwood volume. Conversely, the volume of hardwoods 18 inches and larger represented 17 percent of the total hardwood volume, but only 13 percent of the softwood volume. Species with the greatest volume in the largest diameter classes were white pine and soft maple.

Average volume per acre increases

Further indication of the State's improving forest condition is the increasing volumes per acre on timberland. In 1980, the average growing-stock volume per acre was 1,130 cubic feet, but by 1993 it had increased to 1,430 cubic feet, a 27-percent gain. Average sawtimber volume per acre increased from 2,600 to 3,810 board feet between inventories, a 46-percent gain.

The red pine forest type had the greatest average growing-stock volume per acre in 1993 with almost 1,800 cubic feet, followed by white pine, maple-beech-birch, and paper birch. Forest types with the lowest volumes per acre included tamarack, black spruce, and jack pine, all types common on less productive sites.

In 1993, private owners held two-thirds of the growing-stock volume in the State, and public agencies administered one-third (fig. 14). Private owners held two-thirds of the timberland area as well, making them major influences on the environmental well-being of Michigan's forests, as well as vital suppliers of forest products to the State's citizens and timber industries.

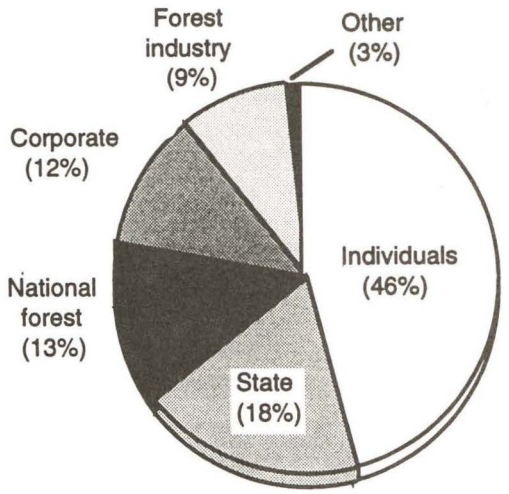

Figure 14.—*Volume of growing stock on timberland by ownership class, Michigan, 1993.*

Private owners held 54 percent of the softwood volume and 72 percent of the hardwood volume in 1993. They also owned 73 percent of the State's growing-stock volume of hard maple, 71 percent of the soft maple volume, and 68 percent of the aspen volume—species with the greatest statewide volumes.

Non-growing-stock trees: sometimes overlooked

The 26 billion cubic feet of growing-stock volume, including the 71 billion board feet of sawtimber volume discussed earlier, does not include the volume in rough, rotten, short-log, or dead trees (non-growing-stock trees). Yet, these trees provide valuable noncommodity as well as commodity values to the State. They furnish important habitat for songbirds, wildlife, insects, and other plants and animals that contribute to biological diversity. Non-growing-stock trees provide visual relief from the sameness of some stands and may be used for fuelwood, pulpwood, pallets, and posts. Future commodity use of these trees will increase as the technology to use short sections of trees is more widely accepted.

Fingerjoining short, high-quality pieces of wood into long, usable pieces is just one way that these non-growing-stock trees can be converted into profitable products. Non-growing-stock volume amounts to 2.9 billion cubic feet, 55 percent of which is in rough trees (table D).

Table D.—*Net volume of non-growing stock on timberland by class of timber and softwoods and hardwoods, Michigan, 1993*

In million cubic feet

Class of timber	All species	Softwoods	Hardwoods
Rough trees	1,596	301	1,295
Rotten trees	461	100	361
Short-log trees	581	100	481
Salvable dead trees	244	81	163
All classes	2,882	582	2,300

Greatest volume in stands aged 41 to 80 years

Half of the total growing-stock volume is in two age classes—the 41- to 60-year class (26 percent) and the 61- to 80-year class (25 percent) (fig. 15). Between inventories, growing-stock volume increased in every stand-age class except the 1- to 20-year class.

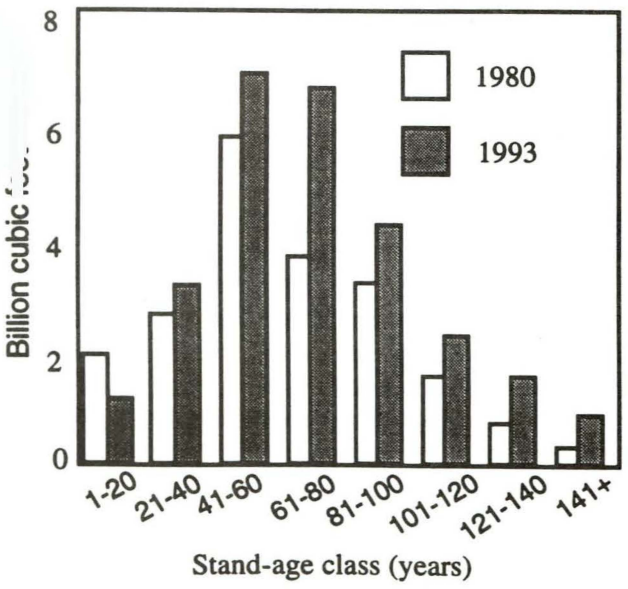

Figure 15.—*Net volume of growing stock on timberland by stand-age class, Michigan, 1980 and 1993.*

In 1993, the maple-beech-birch forest type provided the largest volumes in all age classes. The aspen type contained the second largest volume in the classes ranging from 40 to 70 years of age. However, 14 percent of the volume in the aspen type (430 million cubic feet) was in stands aged 81 years and older—considered to be mature/overmature for aspen. Unless these stands are harvested or disturbed in some way, many of them will convert to another forest type by natural succession.

Most sawtimber volume in lower grade classes

Sawtimber tree quality was assessed by the field crews as they assigned a butt log grade to every softwood sawtimber tree and a tree grade to every hardwood sawtimber tree on about one-third of the field plots. The grades used were based on external characteristics of the trees as indicators of internal quality, such as diameter, number of clear faces on the bole, presence of decay, and amount of sweep and crook (See Survey Procedures in the Appendix). The volume by grade from this sample represents the volume in all trees in the State with a similar log or tree grade.

Smaller diameter trees tend to be assigned the poorer grades because the definition of grades requires that a certain minimum diameter be

met. Because 54 percent of the total sawtimber volume is in trees 14 inches in d.b.h. and smaller, tree quality is weighted toward the poorer end of the spectrum. However, as average tree size continues to increase, average tree quality will also increase. Grade 1 represents the highest quality and grade 4 represents the lowest quality. In 1993, 86 percent of the softwood sawtimber volume was in log grade 3 (fig. 16).

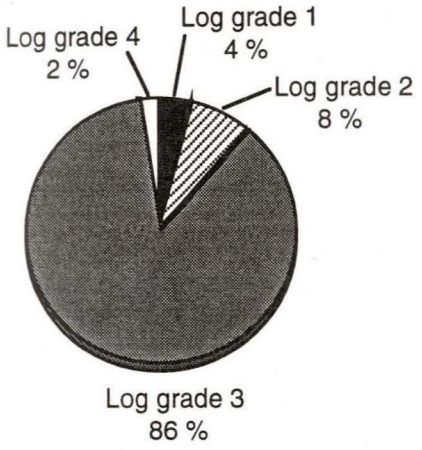

Figure 16.—*Percent of softwood sawtimber volume by log grade, Michigan, 1993.*

Forty-five percent of the hardwood sawtimber volume was in trees classed as tree grade 3 (fig. 17). In 1980, hardwood trees were log-graded, rather than tree-graded, so a comparison cannot be made between the past and present inventories.

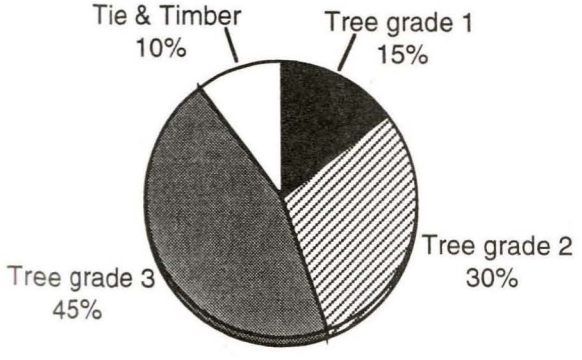

Figure 17.—*Percent of hardwood sawtimber volume by tree grade, Michigan, 1993.*

CAUSES OF CHANGE IN MICHIGAN'S FORESTS

Michigan's forests are dynamic. Changes in area, volume, species composition, number of species, and size all occur continuously from plant succession, growth, natural mortality, and/or environmental and human-caused disturbances. Change factors are discussed separately even though they are inter-related.

Plant Succession

Plant succession, the natural process of gradually replacing one plant community with another, continues to change the forest. Succession takes place as pioneer plant communities, such as jack pine, become established following a disturbance. These initial plant communities modify their physical environment, which enables other plant communities to establish themselves. Examples of such modification include changes in soil organic matter, shade, soil moisture, soil temperatures, and soil nutrients.

The forest land of Michigan underwent extensive disturbance during the early European settlement days as the forests were extensively logged and burned. The forests responded with pioneer species that modified the microclimate, enabling other forest types to establish themselves as understory plant communities. As succession progresses, early successional species are supplanted by more shade-tolerant species and the forests convert to other forest types. This is evident in the results of the 1993 inventory. Biodiversity, in the sense of a landscape mixture or species, can decrease as climax forests become established due to decreased disturbance.

Growth

Growth is an important consideration when discussing forest resources because it is an indication of not only the change in the volume of wood but also the stability, vigor, and stage of development for the stand. Growth is expressed as average annual growth and current growth for both growing stock and sawtimber. For the 1993 inventory of Michigan's forest resources, average annual growth is based on the average growth rate between 1980 and 1992 and current growth is

based on growth in 1992. In the tables, both average annual and current are net growth. Net growth is gross growth minus mortality.

Average net annual growth is a good indication of the average growth rate over time because it averages out periodic factors, such as weather, that could alter the growth rate in a particular year. If one year had significantly different weather conditions and/or abnormal tree mortality, its current growth would be quite different from the average and would probably not be a good indication of the true growth rate. Therefore, average net annual growth is an indicator of overall growth potential over time. However, Michigan's forests changed during the 13 years between inventories. With the long time period between inventories, factors occurring more than 10 years ago affect the average net annual growth rate. Thus, current net growth is an indicator of the most recent stand conditions.

Growing-stock net growth has increased

Between 1980 and 1992, Michigan's forests averaged 764 million cubic feet of net growth each year for growing stock. As a comparison, growing-stock current net growth was 609 million cubic feet in 1979 and 825 million cubic feet in 1992. This represented an increase of more than 36 percent between the two inventories, or a 2.4-percent compound annual increase. Michigan averaged 35 cubic feet of growth per acre on timberland in 1979, compared to 45 cubic feet of growth per acre in 1992.

Pine growth rate exceptional

Between 1980 and 1992, approximately 17 percent of the State total net annual growth in growing stock was in pines. This growth rate was important because pines accounted for only 11 percent of the total acreage. Other conifers represented 14 percent of Michigan's timberland and 14 percent of its average net annual growing-stock growth. In total, conifers averaged 39 cubic feet of growth per acre per year in 1979 and 55 cubic feet in 1992.

With most of Michigan's timberland being in hardwood forest types, most of the average net annual growing-stock growth was from hardwoods. Soft hardwoods accounted for 37 percent and hard hardwoods accounted for 32 percent of the State total for average net annual growing-stock growth.

Growth rates high in the Lower Peninsula

On a regional basis, the Eastern Upper Peninsula Unit had the lowest, and the Southern Lower Peninsula Unit had the highest, average net annual growth for growing stock. In all Units, conifers had higher rates of growth than hardwoods. In 1992, current growth for conifer growing-stock was outstanding in the Northern Lower Peninsula Unit, averaging more than 60 cubic feet per acre per year. Another method of evaluating growth is to determine growth as a percent of volume. In 1992, current net annual growth as a percent of total growing-stock volume averaged 2.8 percent in the Eastern Upper Peninsula Unit, 2.5 percent in the Western Upper Peninsula Unit, 3.4 percent in the Northern Lower Peninsula Unit, and 3.7 percent in the Southern Lower Peninsula Unit. This reflects the better growing conditions found as one moves south in the State. Statewide, Michigan averaged a net annual growth of 3 percent of its total growing-stock volume in 1992.

Private individual ownerships accounted for half of all growing-stock average net annual growth between 1980 and 1992. This was significant because as mentioned earlier, private individuals owned about 45 percent of all timberland. Public owners accounted for slightly less total growing-stock growth than their percent of timberland. For example, National Forests owned 14 percent of the State's timberland but represented only 12 percent of its total growing-stock growth. In Michigan, private individuals tend to own the more productive lands.

Michigan's timberlands are growing at a much faster rate than they are being cut. Between 1980 and 1992, Michigan's average net annual growing-stock growth of 760 million cubic feet far exceeded the State's average annual removals of 274 million cubic feet. Thus, use of Michigan's forests can be expanded without endangering forest land sustainability.

Sawtimber growth rate rises

Between 1980 and 1992, Michigan averaged 2.7 billion board feet of sawtimber growth per year. As a comparison, the 1979 and 1992

sawtimber current annual growth rates were 1.8 billion and 3.1 billion board feet, respectively. Sawtimber growth increases as one moves south in the State, is higher on private lands, and, moving upward. The reader is cautioned not to add growing-stock and sawtimber growth because sawtimber growth is a component of growing-stock growth.

On a per acre basis, Michigan timberland grew about 145 board feet each year between inventories—an impressive figure when one realizes that this includes many acres of sapling/seedling- and poletimber-sized stands. The average annual removal rate was about 45 board feet per acre between 1980 and 1992. Thus, on average, every acre of timberland in Michigan added about 100 board feet of growth after mortality and removals each year. Michigan's sawtimber growth exceeded removals by more than 300 percent over the period 1980 to 1993.

Estimated potential growth can be increased by 50 percent

In 1993, potential net annual growth on timberland for Michigan was estimated to be 1.17 billion cubic feet, about 53 percent higher than average annual growth measured over the last inventory cycle. Potential net annual growth is based on the potential annual volume of growth per acre of fully stocked natural stands at culmination of mean annual increment in each potential productivity class. We multiplied the area in each productivity class by the midpoint of the range of growth in that class to estimate the potential growth in the State. Spurr and Vaux (1976) discounted an estimate of potential growth by 10 percent to adjust for the differences between actual stand conditions and the fully stocked, natural conditions implicit in use of potential productivity data. Thus, we discounted the potential productivity data by 10 percent to more accurately reflect Michigan's current stand conditions (table E).

Michigan's timberlands have the potential to increase their net growth by more than 50 percent based on an average net annual growth of 765 million cubic feet and a potential net growth of 1.17 billion cubic feet. The advantage of increasing net growth is that it does not take additional acres of timberland to increase the future availability of forest resources. With ever-increasing global populations and ensuing pressures on our limited land base for the multitude of land uses found in Michigan, the potential for increased production by expanding the timberland acreage base is limited. The most efficient method of meeting the increased demand for wood fiber is through expanded production on the existing timberlands through more intensive management. With the potential for increasing its net growth, Michigan is in an excellent position to further enhance its standing as the State of the Future for wood and wood products.

Potential growth can be even further advanced if intensive forest management techniques, such as thinning and planting genetically superior trees, are applied. With the potential growth, excellent site conditions, and industry infrastructure, intensive forest management could become an important investment for Michigan's future that will provide many widespread benefits.

Table E.—*Estimation of potential net annual growth on timberland, Michigan, 1993*

Potential productivity class (Feet³/ acre/year)	Timberland area	Potential net growth per acre	Unadjusted total potential growth	Adjusted total potential growth (discounted 10%)
	Thousand acres	*Feet³/ acre/year*	*- - - - - - Thousand feet³/year - - - - - -*	
165 +	122.3	194.5	23,787.4	21,408.7
120-164	837.6	142.0	118,939.2	107,045.3
85-119	4,387.7	102.0	447,545.4	402,790.9
50-84	7,710.1	67.0	516,576.7	464,919.0
20-49	5,558.2	34.5	191,757.9	172,582.1
	18,615.9		1,298,606.6	1,168,745.0

Mortality

Tree mortality is the source of vital components of a stable forest ecosystem. Many insects, diseases, and abiotic factors result in snags (standing dead trees) or cracks, holes, and crooks in the tree. This lowers the timber value but can raise the value of the tree for wildlife. For example, many species of wildlife rely on decay fungi to create rotten pockets in older trees which are then used as sites for nesting, feeding, and roosting. Snags serve as nesting and roosting sites for some wildlife species. Coarse woody debris is important for both terrestrial and aquatic species. It provides both habitat and food for the many fish found in Michigan's streams and rivers.

Statewide, average annual mortality as a percent of total volume was 0.8 percent for growing stock and 0.6 percent for sawtimber in 1993. Total mortality increased between 1980 and 1992 primarily due to increased timberland acreages and volumes; we primarily use percentages rather than total numbers when comparing mortality over time. Species with an above average mortality, when compared to total volume, were jack pine, balsam fir, yellow birch, elm, balsam poplar, aspen, and paper birch. Most of these are either shorter lived, early successional species or are being heavily attacked by pests/diseases.

Typically, more than one factor is involved in a tree's death, and the cause may be difficult to determine. Often, one factor will weaken the tree to the point where a second factor, unable to cause mortality by itself, results in death. Thus, causes for most of the mortality for both growing stock and sawtimber are unknown.

Majority of Michigan's mortality related to diseases

In 1993, the latest inventory, diseases accounted for 57 percent, weather 22 percent, insects 8 percent, humans 8 percent, and animals 4 percent of the known causes of growing-stock mortality. Roughly the same percentages were found for sawtimber. Notably, fire accounted for less than 1 percent of Michigan's average annual mortality. Insects were the leading cause of death for jack pine and select red oak. Weather was the leading cause of death for white and black spruce, balsam fir, northern white-cedar, basswood, red maple, and black ash. Diseases were the leading cause of death for all other species.

Red pine has extremely low mortality

Red pine mortality was less than 0.04 percent of the species' total growing-stock volume between 1980 and 1992, much lower than any other species. Other species with low mortality rates included white pine, northern white-cedar, white oak, beech, and sugar maple. All species with below average mortality rates are late successional species with long life expectancies. As Michigan's forests continue to mature, mortality rates will probably increase because many stands will begin to reach maturity or become overmature, which increases their potential for mortality.

Removals

Timber removals increase

Annual timber removals from growing stock increased from 275 million cubic feet in 1979 to 360 million in 1992, a 31-percent increase (fig. 18). Softwood removals increased from 56 to 85 million cubic feet during the same period, a 50-percent gain. Hardwood removals climbed from 218 to 276 million cubic feet, a 26-percent gain.

The greatest removals volumes in 1992 were for aspen (109 million cubic feet) and for hard maple (42 million cubic feet). However, red pine removals tripled between inventories, increasing faster than that of any species—from 7.8 million cubic feet in 1979 to 23.7 million in 1992. Removals volumes also increased rapidly between inventories for the following species: balsam poplar, black walnut, and paper birch. Removals volumes declined for elms, hemlock, and balsam fir.

Timber removals is made up of three components: roundwood products, logging residues, and other removals (see Definition of Terms in the Appendix). The roundwood products portion, which includes veneer logs, saw logs, pulpwood, and others (firewood, posts, poles, etc.), accounted for 85 percent of the 1992 total removals. Logging residue made up 9 percent of the total, and other removals accounted for the remaining 6 percent. Much of the logging residues and "other removals" is left on site.

Figure 18.—*Removals represent one of the causes of change in Michigan's forests. Harvesting operations, such as shown here, play an important role in Michigan's economy.*

Sawtimber removals for 1992 amounted to 1.1 billion board feet, a 20-percent gain from the 916 million board feet removed in 1979. Softwood sawtimber removals increased 72 percent between inventories, but hardwood removals gained only 9 percent.

The volume of timber removals can fluctuate widely each year as a result of fast-changing economic factors. Therefore, removals for a single year may not be representative of the entire period between inventories. A way of leveling the peaks and valleys of demand is to estimate average annual removals between inventories. Average annual removals of growing stock for the period 1980 to 1992 amounted to 274 million cubic feet, compared to "current" removals of 275 million in 1979 and 360 million in 1992. Likewise, sawtimber average annual removals for 1980-1992 amounted to 777 million board feet, compared to current removals of 916 million in 1979 and 1,101 million in 1992.

Growth exceeds removals

In 1992, current net annual growth on growing stock (825 million cubic feet) was 2.3 times greater than current annual removals (360 million) as shown in figure 19. Average net annual growth of growing stock during 1980-1992 also exceeded average annual removals during the same period, 760 million cubic feet to 274 million, or by 2.8 times. Sawtimber current net annual growth in 1992 (3.1 billion board feet) was 2.8 times higher than current annual removals (1.1 billion board feet).

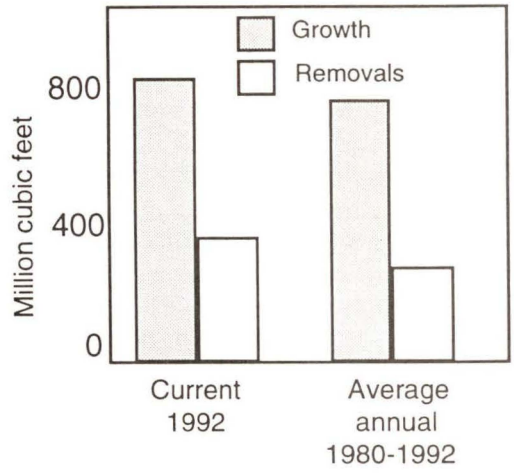

Figure 19.—*Comparison of growing-stock growth and removals for 1992 and for 1980-1992.*

The 1992 current growth of most species was greater than 1992 current removals. For example, growing-stock growth of hard maple (117 million cubic feet) far exceeded removals (42 million). Soft maple growth (115 million cubic feet) was substantially higher than removals (36 million), and red pine growth (83 million cubic feet) comfortably exceeded removals (24 million). Growth of aspens (112 million cubic feet) was much closer to removals (109 million). For jack pine and paper birch, removals were greater than growth.

Biomass

The total aboveground biomass of all live trees (green weight) on timberland amounted to 1,495 million green tons in 1993—an average of 80 green tons per acre. The maple-beech-birch forest type accounted for 46 percent of the total. The aspen forest type was second, with 12 percent of the total, followed by the oak-hickory type with 11 percent, and the elm-ash-soft maple type with 8 percent.

In 1993, the maple-beech-birch forest type had the greatest biomass of live trees per acre—97

green tons per acre. The paper birch type had the next largest biomass with 89 tons, followed by the oak-hickory type (86 tons), and the northern white-cedar type (80 tons). Tamarack, jack pine, and black spruce had the least biomass per acre—40, 42, and 44 tons, respectively. The differences in biomass between forest types are due to variations in the specific gravity of tree species, moisture content, and the mix of species in a type. The largest proportion of live tree biomass was in the boles of growing-stock trees, as shown in table F.

Table F.—*Biomass components for Michigan timberland, 1993*

Biomass component	Weight	Percent
	Million green tons	
Growing-stock trees > 5 in. d.b.h.:		
Stumps	64.9	4
Boles	844.9	56
Tops and limbs	240.9	16
Non-growing-stock trees > 5 in. d.b.h.:		
Stumps	8.9	1
Boles	115.9	8
Tops and limbs	32.9	2
Live 1- to 5-inch trees	186.5	13
Total	1,494.9	100

The above biomass estimates are for all live trees. In addition, we made estimates of shrub biomass on timberland. Shrub biomass includes live tree seedlings less than 1 inch d.b.h., as well as the biomass in tall shrubs and low shrubs. The mean shrub biomass on timberland in 1993 was 3,518 pounds per acre green weight, of which 57 percent was in tree seedlings, 39 percent was in tall shrubs, and 4 percent was in low shrubs. The largest mean shrub biomass was in the balsam poplar and tamarack forest types with 13,149 and 7,298 pounds per acre green weight, respectively. The smallest mean shrub biomass was in the red pine and jack pine forest types with 1,064 and 1,171 pounds per acre green weight, respectively.

Among species of tree seedlings, balsam fir and hard maple produced the largest mean biomass (381 and 326 pounds per acre green weight, respectively). Among tall shrubs, speckled alder dominated with a mean biomass of 990 pounds per acre, followed by hazel with 113 pounds per acre. Blueberry, among the low shrubs, had the greatest mean biomass with 35 pounds per acre.

BENEFITS OF MICHIGAN'S FOREST RESOURCES

Michigan's Forest-Based Economy

Michigan's forests contribute significantly to the social, economic and environmental well-being of the State's citizens. Their economic contribution includes employment opportunities, wealth creation, and production of commodities as well as non-market goods. Timber products and forest-based recreation/tourism are the two major components of the State's forest-based economy (fig. 20). Recent research completed by the Lake States Forest Resource Assessment, sponsored by the Lake States Forestry Alliance, indicates that the strongest and most stable rural economies have forest products industries existing alongside strong tourism/recreation industries (Michigan Department of Natural Resources 1996). During 1994, these combined sectors had a total of more than 85 thousand jobs with a total payroll of more than $3.5 billion. The multiplier effect of employment (those jobs that exist in service industries and other businesses because of the forest-based industries) could boost total employment to more than 200,000 jobs with a total payroll approaching $7 billion.

Figure 20.—*An example of a harvesting operation that represents the two major components of the State's forest-based economy—current timber products harvested and improved access for future forest-based recreation/tourism such as snowmobiling and hunting.*

The timber products industries

The timber products economy consists of two very different components: primary forest products industries and secondary forest products industries. Primary industries produce or use logs, bolts, and chips to manufacture such products as lumber, woodpulp, particle board, and veneer that become raw material for further manufacturing. Most wood used by primary processing plants in Michigan is grown in Michigan. However, inter-state/provincial shipments of logs, bolts, and woodchips is not uncommon. These shipments involve both Michigan-grown wood going to other States or countries for processing as well as wood grown in other States or countries being shipped to Michigan for processing. Secondary manufacturers reprocess the products of primary manufacturers.

Michigan has three major segments of the forest products industry assigned Standard Industrial Classification (SIC) codes by the U.S. Bureau of the Census to compile economic data. The first segment, Lumber and Wood Products (SIC 24), consists of loggers, sawmills, planing mills, manufacturers of prefabricated buildings, and similar industries. The second segment, Furniture and Fixtures (SIC 25), consists entirely of secondary manufacturers who produce such products as wood household furniture, TV cabinets, and wood partitions. Some establishments in this segment are classified as non-wood furniture manufacturers, although they may use some wood components. The last segment is the Paper and Allied Products (SIC 26), which consists of establishments that produce everything from woodpulp to envelopes and shoeboxes. The 1992, Census of Manufacturers data have been updated to 1994 estimates using Michigan Employment Security Commission data (Michigan Department of Natural Resources 1996).

Lumber and wood products

In 1994, this industrial group was estimated to have nearly 1,200 establishments that employed an estimated 17,500 people and had an annual payroll of more than $375 million. These industries had a total value-added by manufacture (the difference between the value of raw materials and the value of goods shipped) of $900 million. The total value of shipments from these mills was estimated at nearly $2 billion.

Of the 1,200 establishments in the lumber and wood products industry, more than half were classified as primary processors. These primary processors included independent logging contractors, sawmills and planing mills, and veneer and board mills. These primary processors employed close to 6,000 people with a payroll of more than $100 million. The total value-added by manufacture for these primary industries was almost $250 million, and the value of shipments approached $550 million.

Although primary wood processors accounted for most establishments in SIC 24, secondary processors accounted for most employment (11,500), payroll ($275 million), value added ($650 million), and value of shipments ($1.4 billion) in the industry (Chappelle and Pedersen 1991). Thus, the more of the secondary or high value added industry that can be retained in the State, the stronger the wood processing industry will be.

Wood furniture and fixtures

This segment of the forest products industry consists entirely of secondary manufacturers. Michigan is a leader in furniture production, particularly the office furniture industry. The 200 establishments in the furniture and fixtures industry that are classified as wood furniture establishments employed about 17,500 people and paid more than $600 million in wages and salaries in 1994. The annual value added by manufacture was estimated to be more than $1.3 billion, and the total value of shipments was estimated at more than $2.5 billion. Availability of wood raw material from nearby sources is a key factor in the economic success of Michigan's wood processing sector. Just how much Michigan-grown wood this industry uses is unknown. However, it has been estimated that about half of all wood processed by all wood-using industries in Michigan was grown in Michigan (Chappelle and Pedersen 1991). Thus, it seems safe to conclude that a substantial share of the wood used in Michigan's furniture industry was grown in Michigan.

Pulp and paper products

The paper and allied products industry in Michigan totaled 250 establishments in 1994 and employed an estimated 21,500 people who earned wages estimated at more than $800

million. Value added and the value of shipments were $2.1 billion and $4.6 billion, respectively. In the paper and allied products industry, only woodpulp mills are classified as primary manufacturers. Most woodpulp mills are associated with a particular papermill. Because of this, the Bureau of the Census showed only one woodpulp mill in 1992. In fact, the 1994 Lockwood-Posts Directory of Pulp, Paper, and Allied Trades lists eight woodpulp mills, all of which are integrated with papermills. These eight mills produce more than 5,000 tons of woodpulp per day.

Forest-based tourism/recreation

Michigan is an important recreation destination for a large segment of the Nation's population. The State provides a diverse mix of recreational opportunities that include hunting, fishing, boating, snowmobiling, skiing, camping, hiking, and sightseeing. In 1994, the tourism and recreation industry in Michigan that can be attributed to forested areas was estimated to directly support more than 30 thousand jobs and to have contributed nearly $2 billion to the State's economy. When jobs created as a result of forest recreation and tourism but not directly a part of this industry are included, these estimates swell to an estimated 50,000 jobs and more than $3 billion contributed to the State's economy.

Biodiversity

Michigan's forested ecosystems are represented by a number of biotic and abiotic components combined into a much broader and diverse landscape. Michigan's statewide forest inventory identified more than 75 different tree species present in the forests. Balsam fir, northern white-cedar, hard maple, soft maple, and aspen account for more than half the number of trees. Woody shrubs totaled approximately 90 species. Speckled alder, blueberry, leatherleaf, and labrador tea were among the most common.

The forest also contains other biotic components that are essential to its overall stability and community functions. The relationship of the many forests and their key attributes to one another create different but important habitats. Examples include the edge between various forests or land uses and the presence of aquatic systems.

As Michigan's forests mature, their structure changes continually. One measure of this process was reflected in the statewide forest inventory. Since 1980, Michigan's forest acreage of larger diameter trees (roughly, greater than 10 inches d.b.h.) increased 55 percent; poletimber (5- to 10-inch trees) acreage decreased 27 percent; and seedling/saplings (under 5 inches) remained relatively constant. The trend towards maturity in Michigan's forests provides multiple management opportunities. Choices range from managing for old-growth attributes to harvesting the mature tees to improve structural diversity or regenerate the forests.

Forest Health

Forest stressors such as drought, storms, late spring frosts, diseases and insects, coupled with the age of several forest types, have played a significant role in shaping Michigan's forests. Generally, Michigan's forests are quite stable and productive. However, some localized problems have occurred in types, such as jack pine and aspen, that are beyond pathological rotation age, especially in even-aged stands. Recent events affecting the overall vigor of Michigan's forests included significant statewide storm damage during 1995, an expansion of gypsy moth defoliation into more counties, and an outbreak of larch casebearer defoliation affecting tamarack. To reduce the risk of unnecessary timber resource loss and future scarcity, foresters are attempting to adjust the current age-class distribution in Michigan.

Michigan's Special Plants

Michigan has just over 1,800 species of native plants (table G). It has diverse habitats ranging from prairie and southern forests to boreal species with several endemic species of plants associated with the Great Lakes shorelines. The primary distribution of three threatened endemic species—dwarf lake iris (*Iris lacustris*), Pitcher's thistle (*Cirsium pitcheri*), and Houghton's goldenrod (*Solidago houghtonii*)—is found in Michigan.

An additional 800 non-native species have been introduced into the wild flora of Michigan, some intentional and some unintentional. Many of the introduced species are commonly

Table G.—*Michigan plant species by origin*

Plant type	Quantity	% of Native plants
Extirpated	34	1.9
Endangered	31	1.7
Threatened	209	11.6
Special concern	123	6.8
Secure plant	1,403	78.0
Total native plant species	1,800	100
Alien plants with established populations	800	
Total plant species	2,600	

known weeds. Some alien species, including Eurasian millfoil, garlic mustard, spotted knapweed, and purple loosestrife have become serious problems in some wetlands and natural areas.

Development of uplands and shorelines, wetland drainage, and conversion of woodlands and grasslands to agricultural purposes have diminished Michigan's flora. Michigan has lost 34 native plant species in recent times; it currently has 31 endangered plants, 209 threatened plants, and 123 plants listed as of special concern. About 22 percent of Michigan's native plant species are at risk. The most complete database for Michigan's special plants is maintained by the Natural Heritage Program in the Department of Natural Resources-Wildlife Division.

Forest Wildlife

Although white-tailed deer are the most easily recognized of Michigan's forest residents, a unique collection of wildlife species is supported by various forest ecosystems in the State. Anyone who has spent much time in Michigan's forests will recognize the important role forests play in maintaining the State's wildlife diversity.

Southern Michigan forests host many species that live there year-round, such as fox squirrels, turkeys, and white-tailed deer. These forests also provide an important stopover for fall and spring travelers. Neo-tropical migratory birds, on their way to northern breeding grounds, use the larger existing forest tracts as resting sites. These forests provide the only major resting opportunity between the Ohio River and more northerly forests.

The mixed northern hardwood and aspen forests are the mainstay of habitat for Michigan's grouse and deer populations. The younger forests created from harvests or other disturbances are also heavily used by several species of warblers and ground nesting birds.

Travelers from all over the world visit the jack pine forests of northern Michigan. This unique forest system is the only nesting site in the world for the endangered Kirtland's warbler. Evolved over thousands of years, this dry forest became dependent on fire for regeneration. Maintenance of this system requires intensive forest management to regenerate young jack pine stands needed to sustain critical habitat for the warbler.

The forests of Michigan have supported the return of gray wolves, which have expanded their range from both Wisconsin and Ontario. Their neighbors include bald eagles, pine marten, beaver, and moose.

Small, annually temporary ponds and wetlands scattered throughout the forests are essential for the reproduction of salamanders and frogs. These flooded forest areas, as well as other floodplain forests, provide habitat for many waterfowl species and the State-threatened red shouldered hawk. Cool waters shaded by lowland forest also provide habitat for wood turtles.

It is no wonder wildlife recreation significantly contributes to both local and State economies. Existing populations of deer, bear, turkey, grouse, and furbearers generate more than $600 million in revenue statewide. Wildlife viewing and photography continue to grow in

some areas, such as in northern Michigan where elk viewing has become a popular pastime.

In addition to the quantifiable values of the forest's wildlife resources are the intangible benefits provided by just knowing that forests are teeming with hundreds of species of mammals, birds, insects, and amphibians.

Forest Recreation

Michigan's forests provide a unique opportunity to fill a recreation niche. They provide for activities that depend on a large, lightly used land base, and for smaller, more intensively managed activities that are best enjoyed in a forest setting.

Private forest lands provide day use opportunities on some of the larger corporate ownerships, and more intensively developed and concentrated outdoor experiences on some of the smaller ownerships. Public forest lands, administered by local, State, and Federal agencies, also provide similar experiences, but generally on a more dispersed, broader scale.

Michigan's State Forests cover more than 3.7 million acres and are the largest State Forest system in the Eastern United States. These State Forests support one of the largest rustic recreation systems in the United States while providing opportunities for camping, hiking, hunting and fishing, snowmobiling, off-road vehicle riding, and sightseeing. Boating, picnicking, mushroom and blueberry picking, horseback riding, and nature photography are activities that round out the array of opportunities available. Forest campgrounds and rustic cabins are a mainstay of this system, many providing access to lakes and rivers.

Urban and Community Forestry

Michigan's population of 9.3 million people lives predominantly in the southern one-third of the State; 3.9 million people live in Macomb, Oakland, and Wayne counties alone. The natural resource base in this area can be improved through management, thus having a positive impact on quality of life. This natural resource base includes the soil, trees, shrubs, open space, streams, air, plants, animals, and birds that inhabit our suburban, urban and rural communities. Urban and community forestry deals with the interaction of people and forest resources to ensure long-term community and ecological sustainability, improved environmental quality, and improved quality of life.

Community tree resources provide a range of environmental benefits: energy efficiency, carbon sequestration, oxygen production, erosion control, protection of water quality, maintenance of biophysical diversity (plant and animal), and noise reduction. They improve people's physical and mental health and enhance spiritual, emotional, and cultural well-being.

MICHIGAN'S FUTURE TIMBER RESOURCE

Projections Suggest A Great Future Timber Supply

We made two sets of 30-year projections of the State's supply of timber to gain an understanding of the possible outlook for Michigan's forests and for the forest-based economy, and to assess the role of the State in helping to meet the Nation's timber demand. One of the projections (consistent removals option) assumes that growth and removals will follow the same trends as occurred between the 1980 and 1993 inventories. The other projection assumes an accelerated level of timber removals (accelerated removals option). Separate sets of projections were made for softwoods and hardwoods.

Assumptions used in making the projections are:

1. The total area of timberland will decrease from 18.6 million acres in 1993 to 18.2 million in 2023, an average decline of 0.071 percent per year.

2. The availability of timberland for harvest will remain the same as it was in the recent past.

3. For the consistent removals option projections growth rates for softwoods (3.28 percent of inventory in 1992) and for hardwoods (3.02 percent) will remain constant at the 1992 level throughout the projection period; for the accelerated removals option, growth rates will increase on a straight line from 3.28 percent in 1992 to 3.44 percent in 2023 for softwoods, and from 3.02 percent in 1992 to 3.17 in 2023 for hardwoods.

4. For the consistent removals option projection removals rates for softwoods (1.11 percent in 1992) and for hardwoods (1.45 percent) will remain constant at the 1992 level; for the accelerated removals option, the removals rate will increase in a straight line to 2.61 percent in 2023 for softwoods, and 2.50 percent for hardwoods.

5. There will be no change in the economic, social, or political structure.

Consistent Removals Option Projection

In this projection for growing stock, total net annual growth for both softwoods and hardwoods rises from 825 million cubic feet in 1992 to 1,364 million in 2023, a gain of 65 percent (fig. 21). Timber removals increases from 360 to 588 million cubic feet between 1993 and 2023, a 63-percent gain. Growth remains higher than removals throughout the projection period, and the difference between the two continues to widen until by 2023, growth exceeds removals by 776 million cubic feet. As a result of this increasing disparity of growth over removals, the inventory of all species continues to expand from 26.6 to 43.9 billion cubic feet from 1993 to 2023, an increase of 65 percent. Mortality, which has been subtracted from gross growth to yield the net annual growth shown above (825 million cubic feet in 1992), rises from 200 to 360 million cubic feet between 1992 and 2023.

If the consistent removals option projections for softwoods are analyzed separately from those for hardwoods, they show a very strong similarity to the all species projections. Softwood growth increases from 249 to 463 million cubic feet during the period 1993 to 2023. Softwood removals increase from 85 million cubic feet in 1993 to 157 million in 2023, but remain much lower than growth during the entire period. This excess of growth results in an expansion of the softwood inventory from 7.6 to 14.1 billion cubic feet during the projection period, a gain of 86 percent.

Hardwood growth is projected to increase from 576 to 901 million cubic feet between 1993 and 2023. Hardwood removals lag behind growth but increase from 276 to 431 million cubic feet during the period. Hardwood inventory responds by increasing from 19.1 to 29.8 billion cubic feet, a 56-percent increase.

Accelerated Removals Option Projection

The accelerated removals option shows growing-stock net annual growth increasing, but less than in the consistent removals option—from 825 to 1,234 million cubic feet from 1993 to 2023 (fig. 22). Growth remains greater than removals throughout the projection period, but removals increase faster than growth. Growth and removals tend to approach each other, although growth is projected to exceed removals in 2023 by 274 million cubic feet. Removals increase from 360 to 960 million cubic feet

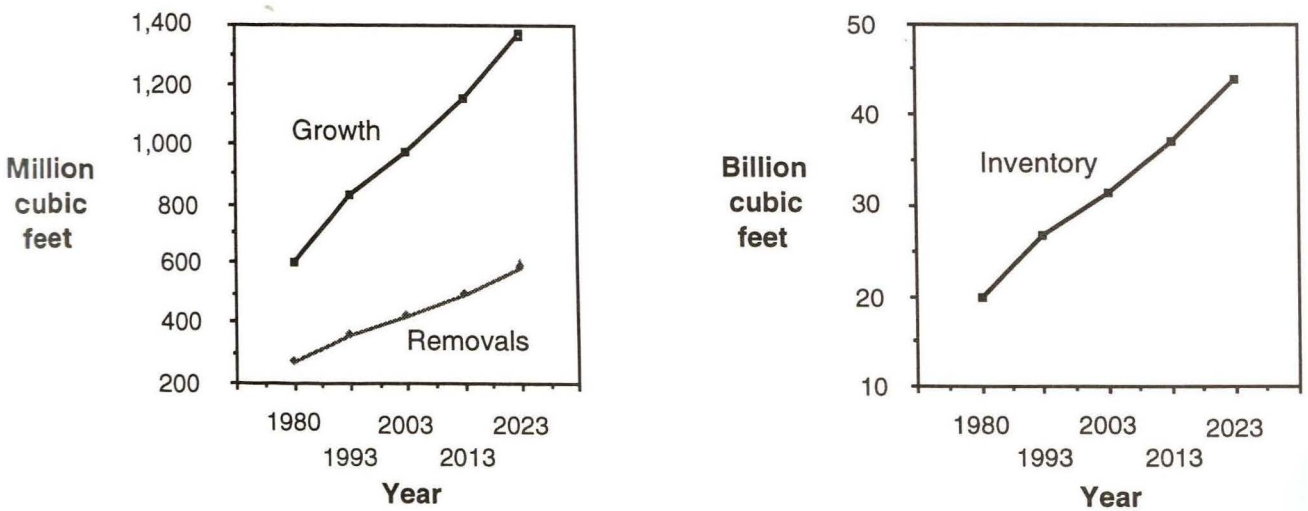

Figure 21.—*Removals, net annual growth, and inventory of growing stock on timberland, Michigan, 1980 and 1993, and consistent removals option projections to 2023.*

from 1993 to 2023. Inventory responds to this narrowing of the difference between growth and removals by continuing to increase but at a decreasing rate, from 26.6 to 37.9 billion cubic feet between 1993 and 2023.

In this option, softwoods net annual growth increases from 249 million cubic feet in 1993 to 401 million in 2023, a gain of 61 percent. Removals of softwoods surge from 85 to 304 million cubic feet during the projection period, a 260-percent increase. Growth and removals move towards each other, but by 2023, growth is greater than removals by 96 million cubic feet. Inventory of softwoods builds from 7.6 to 11.7 billion cubic feet, a 54-percent increase.

Hardwoods growth increases from 576 million cubic feet in 1993 to 834 million in 2023, a 45-percent gain. Removals of hardwoods increases from 276 to 656 million cubic feet during the same period, a 138-percent increase. Growth exceeds removals by 300 million cubic feet in 1993, but by 2023, the difference between the two shrinks to 178 million. Inventory increases from 19.1 billion cubic feet in 1993 to 26.3 billion in 2023, a 38-percent gain.

The Outlook

These projections probably represent the high and low bounds within which Michigan's future forests may develop. The projections represent the true situation over the next 30 years only if our assumptions prove to be reasonably accurate. Projections made for the first decade are more dependable than those for the last 2 decades because the fast-changing economic, political, and market conditions tend to make long-range projections less reliable.

Growing-stock inventory will continue to increase, much as it has for the last 60 years, as the average tree size increases, and as the volume of net growth continues to exceed the volume of removals. The inventories of individual species will differ in their rate of change based on differences in market demand, their growth rates, the effects of plant succession, their susceptibility to agents that cause large-scale mortality, their accessibility and availability, and other factors. Hardwoods will remain dominant, although the faster growing softwoods will make up a larger share of the inventory.

The intensive application of forest management techniques such as the selection by professional foresters of trees to be harvested, tree planting (especially using genetically superior seedlings), and stand improvement practices could result in higher growth rates and larger inventories than those projected. In addition, inventories can be extended by

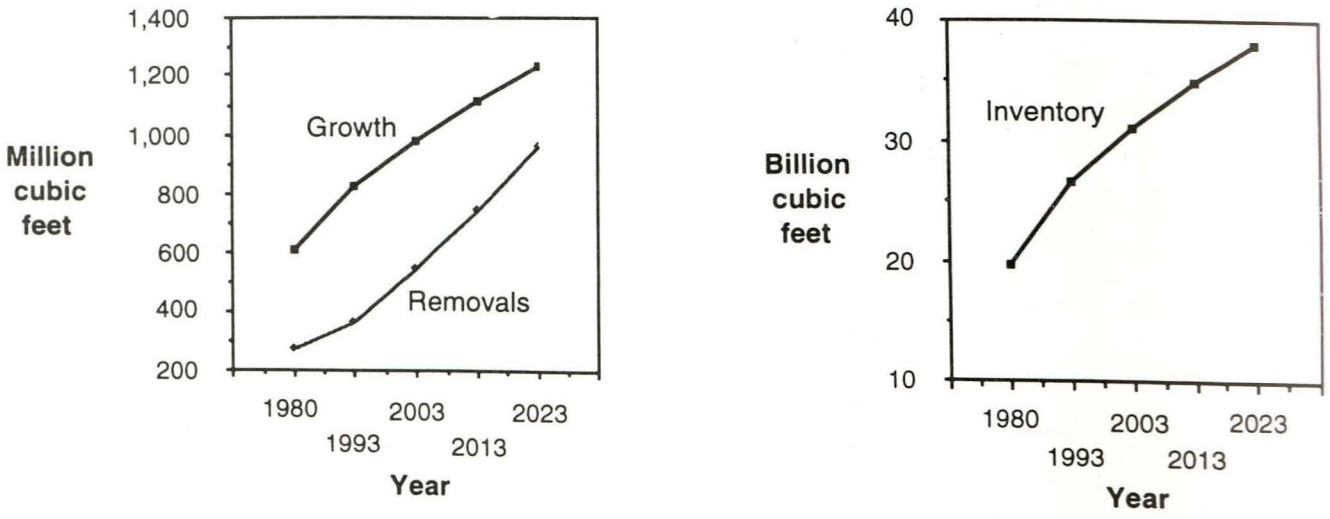

Figure 22.—*Removals, net annual growth, and inventory of growing stock on timberland, Michigan, 1980 and 1993, and accelerated removals option projections to 2023.*

increased use of wood residues, tree tops and limbs, the volumes of which are not included in growing-stock inventories. Greater use of short-log, rough, and rotten trees, which are part of the non-growing-stock resource, will also stretch inventories.

Many methods for using small diameter, poor quality, or noncommercial trees have been researched by the Forest Service's Forest Products Laboratory, including finger-joining small sawn sections to make standard size lumber; using adhesives to manufacture structural wood products from wood veneer, flakes, and fibers; combining wood and plastics or cement to produce dimensionally stable, decay- and fire-resistant products; and producing laminated veneer lumber. As these and other technologies are implemented more widely in the future, demand will increase for trees that are presently difficult to sell.

The area of the maple-beech-birch forest type, which increased from 6.2 to 7.2 million acres between 1980 and 1993, is likely to continue to expand in the future. Sugar maple, one of the mainstays of this type, is long-lived, tolerant of shade, and can thrive in the understory of other forest types. If those overstory trees are removed by harvest or mortality, the understory maples and associated species are in a position to convert the site to the maple-beech-birch type, already the most common type in the State.

One of the forest types that has contributed to the gains of the maple-beech-birch type is the aspen type. This early successional type, which declined from 3.1 to 2.7 million acres from 1980 to 1993, is composed largely of short-lived quaking and bigtooth aspens, which are intolerant of shade. To regenerate to aspen, these stands require major disturbances such as fire, harvest by clear-cutting, or widespread natural mortality to open the stand to full sunlight. If an aspen stand survives these disturbances but dies of old age (around 60 years), the stand will likely convert to the tolerant species growing in the understory at the time. In many cases, these tolerant species are associated with the maple-beech-birch type. The aspen type area is expected to continue to decline as older aspen stands reach maturity without disturbance of any kind (fig. 23).

Maintaining the early successional tree species and their associated values requires sustained and regular forest disturbances. Values associated with climax forests can be achieved by minimizing or excluding forest disturbances. A diversity of other objectives can be achieved by other levels of forest management. Careful planning is required to determine the best mix of forest conditions required to address current and future social, economic, and environmental goals.

Figure 23.—*If the area of aspen continues to decline, careful management decisions must be made to ensure that benefits associated with this forest type continue to be provided in the future.*

Reduced harvests from public forest lands, particularly the National Forests, in response to pressure from environmental interest groups could translate into greater harvests from privately owned forests. As consumption of wood products increases and as timber harvest expands during the next 30 years, it

seems likely that private forests will provide more of the supply than they have in the past. This greater reliance on private timberlands indicates a need for an expanded forestry extension and technical assistance program to reach landowners who may not be aware of forest management techniques that will help them be more efficient and profitable.

The use of Michigan's forests, like the use of forests around the country, is coming under closer scrutiny from the public. Wildlife, recreation, esthetic beauty, clean water, biological diversity—commodity and non-commodity products of the forests—are important now, but will be increasingly important in the future. The mix of products we choose will significantly impact the way forest lands are managed in the years ahead, and will largely determine the future issues that will be debated by commodity and non-commodity users of the forest.

APPENDIX

ACCURACY OF THE SURVEY

Forest Inventory and Analysis information is based on a sampling procedure designed to provide reliable statistics at the State and Survey Unit levels. Consequently, the reported figures are estimates only. A measure of reliability of these figures is given by sampling errors (table H). These sampling errors mean that the chances are two out of three that if a 100-percent inventory had been made, using the same methods, the results would have been within the limits indicated.

For example, the estimated growing-stock volume in the State in 1993, 26,856.5 million cubic feet, has a sampling error of ± 0.67 percent (± 179.9 million cubic feet). The growing-stock volume from a 100-percent inventory would be expected to fall between 26,676.6 and 27,036.4 million cubic feet (26,856.5 ± 179.9), there being a one in three chance that this is not the case.

As survey data are broken down into sections smaller than State totals, the sampling error increases. For example, the

Table H.—*Sampling errors for 1993 inventory of Michigan's forest resources*

Item	State totals	Sampling error
Growing stock	*Million cubic feet*	*Percent*
Volume (1993)	26,856.5	0.67
Average annual growth (1980-1992)	764.5	0.91
Average annual removals (1980-1992)	275.7	4.02
Sawtimber	*Million board feet*	
Volume (1993)	72,015.6	0.94
Average annual growth (1980-1992)	2,690.3	1.06
Average annual removals (1980-1992)	783.8	4.73
	Thousand acres	
Timberland area (1993)	18,615.9	0.34

sampling error for timberland area in a particular county is higher than that for total timberland area in the State. To estimate sampling error for data smaller than State totals, use the following formula:

$$E = \frac{(SE)\sqrt{(\text{State total volume or area})}}{\sqrt{(\text{Volume or area smaller than State total})}}$$

Where :

E = Sampling error in percent.

SE = State total error for volume or area.

For example, to compute the error on the area of timberland in the maple-beech-birch type for the State, proceed as follows:

1) Total statewide area of maple-beech-birch type = 7,161.3 thousand acres.
2) Total statewide area of all timberland = 18,615.9 thousand acres.
3) The State total error for timberland area = 0.34 percent.
4) Using the above formula:

$$E = \frac{0.0034\sqrt{18,615.9}}{\sqrt{7,161.3}}$$

E = 0.0055 or 0.55 percent sampling error for the maple-beech-birch forest type in Michigan.

County Data

A standard FIA inventory is designed to provide sampling errors of no more than 3 percent per million acres of timberland or an overall error on Michigan's nearly 18,616 million acres of about 0.7 percent. More accurate survey information was obtained during this survey than otherwise would have been feasible because of intensified field sampling. Sampling intensity was increased from a single intensity level to a triple intensity level in the Eastern and Western Upper Peninsula Units, from a single intensity level to a double intensity level in the Northern Lower Peninsula Unit, and kept at a single intensity level in the Southern Lower Peninsula Unit. The goal was to provide a sampling error of less than 10 percent for total timberland area by county from the increased sampling intensity in the Units intensified. Such sampling was made possible through the cooperation, assistance, and additional funding provided by the State of Michigan and Michigan forest industries and associations. In addition, to aid in determining current timber removals, the Michigan Department of Natural Resources (MiDNR) also surveyed primary wood-using plants in the State. Sampling errors for area, volume, growth, and removals, for both growing stock and sawtimber, for each county in Michigan are shown in the last table in this publication.

The sampling error within a county depends on county size and total area of timberland. Many large, heavily forested counties in the State have sampling errors well below 5 percent. However, in counties where timberland area is less than 35,000 acres, the sampling error for the total area in timberland will generally exceed 10 percent. The sampling error for total timber volume in a reporting area containing 35,000 acres of timberland will be about 20 percent.

COMPARING MICHIGAN'S FIFTH INVENTORY WITH THE FOURTH INVENTORY

A new volume estimation procedure was developed for the Lake States; this procedure was used to compute the 1992 volumes and also to recompute the 1980 volume for growth calculations. Although the adjustment will differ by Survey Unit and species, the recomputed 1980 growing-stock and sawtimber volumes will generally be greater than those shown in the 1980 report. Past surveys used only growing-stock trees to determine stand-size class. Current survey procedures require that stand-size class be determined on the basis of all live trees. Therefore, direct comparisons of current inventory data to old inventory data by stand-size class may be misleading.

The basic building block for estimating forest area and timber volume has been changed from the Survey Unit to the county. In the past, the statistics were developed at the Unit level and prorated back to the county on the basis of photo-interpretation points. Direct development of county-level data helps users interested in more precise local data, but can make the outcome of comparisons with past estimates imprecise.

SURVEY PROCEDURES

The 1993 Michigan survey used a growth model-enhanced, two-phase sample design. Using this sampling scheme and associated estimators is similar to sampling with partial replacement, in that a set of randomly located plots is available for remeasurement and a random set of new plots is established and measured. A feature of the new Michigan design is stratification for disturbance on the old sample and use of a growth model to improve regression estimates made on old undisturbed forest plots (fig. 24). Detailed descriptions of the sampling and estimation procedures are presented by Hansen (1990). The growth model used in the Michigan survey design was the Lake States Stand and Tree Evaluation and Modeling System (STEMS) (Belcher *et al.* 1982).

Major Steps in the New Survey Design

1. Aerial photography (Phase 1)

In this phase, two sets of random points were located on current aerial photography. The first is a set of new photo plots and the second is a set of relocated old ground plot locations from the 1980 inventory. Aerial photographs used were black and white, infrared taken in 1986 for the Upper Peninsula, 1987 for the Northern Lower Peninsula, and 1988 for the Southern Lower Peninsula at a scale of 1:15,840 (nominal). These photographs were purchased by the MiDNR and loaned to the Forest Service. The locations of the plots used in the 1980 inventory were transferred to these new photographs. The photographs were then assembled into township mosaics, and a systematic grid of 121 one-acre photo plots (each plot representing approximately 190.4 acres) was overlaid on each township mosaic. Each of these photo plots was examined by aerial photo interpretation specialists and classified stereoscopically based on land use. If trees were present, forest type and stand-size/density class were recorded. After this examination, all the old "disturbed" sample locations and one-third of the old "undisturbed" forested plots were sent to the field for survey crews to verify the photo classification and to take further measurements. All photo plot locations for the 1993 inventory were examined and were classified as shown in table I:

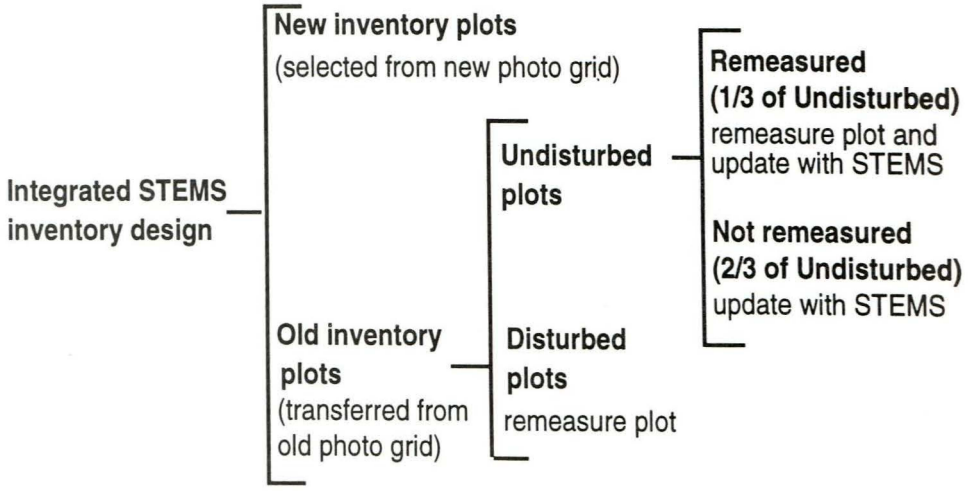

Figure 24.—*Overview of the Michigan sample design.*

Table I.—*Photo plot classifications, 1993 inventory of Michigan's forest resources*

Photo land class	Photo plots
Timberland	97,851
Reserved forest land	2,512
Other forest land	1,014
Questionable	3,036
Nonforest with trees	7,438
Nonforest reserved	471
Nonforest without trees	79,425
Water	5,204
All classes	196,951

2. Plot measurements (Phase 2)

On plots classified as timberland, wooded pasture, or windbreak (at least 120 feet wide), a ground plot was established, remeasured, or modeled. Old plots sent to the field for remeasurement that could not be relocated were replaced with a new plot at the approximate location of the old one. Each ground plot consisted of a 10-point cluster covering approximately 1 acre. At each point, trees 5.0 inches or more in d.b.h. were sampled on a 37.5 Basal Area Factor (BAF) variable-radius plot, and trees less than 5.0 inches d.b.h. were sampled on a 1/300-acre fixed-radius plot. The measurement procedure for the new and old sample locations were as follows:

a) New inventory plots

A systematic sample of the new photo plots was selected for field measurement. Ground plots were established, and measures of current classification such as land use, forest type, and ownership as well as size and condition of all trees on the plot were recorded. These locations were monumented for future remeasurement.

b) Old inventory plots

These plots were established, monumented, and measured as part of the 1980 field inventory. The procedures for these old plots were different from those for the new plots. Old plots were classed as "undisturbed" or "disturbed" in the aerial photo phase of the sampling process. All disturbed plots and a one-third sample of the undisturbed plots were remeasured to obtain estimates of current condition and changes since the last inventory. All trees measured on these plots in 1980 were remeasured or otherwise accounted for, and all new trees were identified and measured.

All sample plots that were forested at the time of the 1980 inventory and determined to be undisturbed until this inventory were projected to the current time using STEMS. This procedure gives projected estimates of current volume and growth for these undisturbed plots. The comparison of the projected and observed values on the one-third sample of the undisturbed forest plots that were remeasured provided local calibration data to adjust the projected values of the undisturbed plots that were not remeasured. The adjustment procedure is a modified version of the method described by Smith (1983).

The undisturbed forested plots that were not remeasured play a crucial role in the new survey design. These plots were determined to be undisturbed and had conditions that could be simulated by STEMS. The STEMS growth model was used to "grow" the old plot and tree data to produce an estimate of current data. Thus, these plots were treated as ground plots, even though they were never visited. The plot record for each modeled plot was sent to the field for verification of current ownership information.

All old plots classified as disturbed were sent to the field for remeasurement to assess and verify changes since the last inventory. Disturbance refers to any change on a plot that can be detected on aerial photos and that the STEMS growth processor cannot predict, such as catastrophic mortality, cutting, seedling stands, and land use change.

The estimation procedure for computing statistics from this sampling design was more complicated than the simple two-phase estimation procedure used in the past. In fact, this procedure yielded two independent samples, one coming from the new photo points and the other from the old photo points that are remeasured or modeled. Table J summarizes the distribution of all ground plots for the new inventory design by type of plot:

Table J.—*Distribution of ground plots for the 1993 inventory of Michigan's forest resources*

Ground land use class	Old plots remeasured	Old plots updated	New plots	Dropped or denied access	Total plots
Timberland	4,180	4,021	2,023	2	10,226
Reserved forest land	87	3	472	0	562
Other forest land	46	1	16	1	64
Nonforest with trees	372	148	147	1	668
Nonforest without trees	1,997	3,254	1,160	1	6,412
Water	99	304	154	37	594
Other	0	0	0	58	58
Total	6,781	7,731	3,972	100	18,584

3. Area estimates

Area estimates were made using two-phase estimation methods. In this type of estimation, a preliminary estimate of area by land use is made from the aerial photographs (Phase 1) and corrected by the plot measurements (Phase 2). A complete description of this estimation method is presented by Loetsch and Haller (1964).

4. Volume estimates

Estimates of volume per acre were made from the trees measured or modeled on the 10-point plots. Estimates of volume per acre were multiplied by the area estimates to obtain estimates of total volume. Net cubic foot volumes are based on a modification of the method presented by Hahn (1984) for use in the Lake States. For the Michigan inventory, the merchantable height equation presented in Hahn (1984) was used in conjunction with Stone's equation (see Appendix I in Hahn 1984) to estimate gross volume. This estimate was then corrected by species for variation in bark and cull volume to yield an estimate of net volume, using the coefficients presented in Hahn (1984).

The Forest Service reports all board foot volume in International 1/4-inch rule. In Michigan, the Scribner log rule is commonly used. Scribner log rule conversion factors were derived from full tree measurements taken throughout the Lake States (Michigan, Wisconsin, and Minnesota) and an equation developed by Wiant and Castenaeda (1977). The factors (multipliers) used to convert board foot International volumes to the Scribner rule are shown in the following tabulation:

D.b.h. (inches)	Scribner rule conversion factor	
	Softwoods	Hardwoods
9.0-10.9	0.7830	—
11.0-12.9	0.8287	0.8317
13.0-14.9	0.8577	0.8611
15.0-16.9	0.8784	0.8827
17.0-18.9	0.8945	0.8999
19.0-20.9	0.9079	0.9132
21.0-22.9	0.9168	0.9239
23.0-24.9	0.9240	0.9325
25.0-26.9	0.9299	0.9396
27.0-28.9	0.9321	0.9454
29.0+	0.9357	0.9544

5. Growth and mortality estimates

On remeasured plots, estimates of growth and mortality per acre come from the remeasured diameters of trees and from observation of trees that died between inventories. Growth reported as the average net annual growth between the two inventories (1980 and 1993) is computed from data on remeasured plots and modeled plots using methods presented by Van Deusen *et al.* (1986). Mortality is also average net annual for the remeasurement period. On new plots, estimates of growth and mortality were obtained by using STEMS to project the growth and mortality of trees for 1 year. Growth and mortality estimates for old undisturbed plots that were updated were derived in the same manner as remeasured plots. The STEMS growth model was adjusted by Survey Unit to meet local conditions, using data from the undisturbed remeasurement plots. As with volume, total growth and mortality estimates were obtained by multiplying the per acre estimates by area estimates. Current annual growth for 1992 was computed by using the adjusted STEMS model to grow all current inventory plots for 1 year.

6. Average annual removals estimates

Average annual growing-stock and sawtimber removals (1980 to 1992) were estimated only from the remeasured plots; new plots and STEMS-projected plots were not used to estimate removals. These estimates are obtained from trees measured in the last survey and cut or otherwise removed from the timberland base. Because remeasurement plots make up about one-half of the total ground plots, average annual removals estimates have greater sampling errors than volume and growth estimates.

7. 30-year projection estimates

We made a consistent removals option projection of Michigan's timber resource based on a continuation of contemporary timber removals rates, as well as an accelerated removals option projection based on an increase in timber harvesting in the State. We made separate projections for softwoods and hardwoods, by using a spreadsheet technique. Columns in the spreadsheet included:

a. Year (with rows from 1992 to 2023)
b. Area of timberland
c. Total growing-stock volume
d. Growing-stock volume per acre
e. Volume of growing-stock growth per acre
f. Volume of growing-stock removals per acre
g. Total volume of growing-stock growth
h. Growing-stock growth rate (growth volume as a percent of inventory volume)
i. Total volume of growing-stock removals
j. Growing-stock removals rate.

The first step was to assume the area of timberland for each of the 30 years in the projection period. For Michigan, we assumed that timberland area would decline from 18,616 thousand acres in 1993 to 18,226 thousand in 2023, an average decline of 0.0698 percent per year. This rate of decline was assumed for both the low and high removals option projections. The assumed area of timberland for each year was recorded in the proper cell.

For the consistent removals option, we assumed the 1992 growth rate (3.28 percent for softwoods and 3.02 percent for hardwoods) would remain constant throughout the 30-year projection period. For the accelerated removals option, we assumed the softwood growth rate would rise evenly from 3.28 percent in 1992 to 3.44 percent in 2023, and that the hardwood growth rate would rise from 3.02 percent in 1992 to 3.18 percent in 2023.

We assumed removals rates for the consistent removals option would remain constant throughout the period at the 1992 level (1.11 percent for softwoods, and 1.45 percent for hardwoods). For the accelerated removals option, we assumed that softwood removals rates would increase evenly from 1.11 percent in 1992 to 2.61 percent in 2023, and that the hardwood removals rates would rise evenly from 1.45 percent in 1992 to 2.50 percent in 2023. The assumed removals rates and growth rates were recorded in their proper cells.

Because the total growing-stock volume for 1993 was known (7,572,070 thousand cubic feet for softwoods, and 19,072,815 thousand for hardwoods), the total removals volume for 1993 could be estimated by multiplying the 1993 removals rate by the 1993 total growing-stock volume. By dividing the total removals volume for 1993 by the 1993 area of timberland, an estimate could be made of the 1993 removals per acre.

Similarly, the 1993 total volume of growing-stock growth for both softwoods and hardwoods could be estimated by multiplying the 1993 growth rate by the 1993 total growing-stock volume. By dividing the 1993 total growth volume by the 1993 area of timberland, the 1993 growth per acre could be estimated and entered into the proper cell. The 1993 growing-stock inventory volume per acre could be estimated by dividing the 1993 total growing-stock volume by the 1993 area of timberland.

When the last cell in the spreadsheet row for 1993 was completed, we instructed the spreadsheet application to add the 1993 growth per acre to 1993 inventory volume per acre, then to subtract the 1993 removals per acre, and to enter the resulting number in the cell for 1994 inventory volume per acre. This estimate, when multiplied by the 1994 area of timberland, yielded the estimated total inventory volume for 1994. The spreadsheet application followed the same procedure for each row, until estimates for all 30 years had been completed.

Tree and Log Grades

Log grades and tree grades are based on the classification of external characteristics as indicators of quality. Log grades and or tree grades were taken on approximately one-third of the sample plots in Michigan. All sawtimber softwood sample trees were graded for quality and assigned a butt log grade. All sawtimber hardwood sample trees were graded for quality and assigned a tree grade. The volume yield by log grade or tree grade for this sample was used to distribute the volume of the ungraded sample trees by species group.

Hardwood sawtimber trees were graded according to "Hardwood tree grades for factory lumber" (Hanks 1976). The best 12-foot section of the lowest 16-foot hardwood log was used for grading. Hardwood sawtimber trees that did not meet minimum tree grade specifications for grades 1 through 3 were assigned grade 4 according to Forest Service standard specifications for hardwood construction logs described in "A guide to hardwood log grading" (Rast *et al.* 1973).

Red pine and jack pine sawtimber trees were graded based on specifications described in "Forest Service Log Grades for Southern Pines" (Campbell 1964). White pine and other softwood sawtimber trees were graded according to specifications described by Ostrander and Brisbin (1971). For all softwoods, the first merchantable 16-foot log, or shorter lengths down to 12 feet, was used for grading.

Hardwood Tree Grade for Factory Lumber [a]

Grade factor	Tree grade 1	Tree grade 2	Tree grade 3
Length of grading zone (feet)	Butt 16	Butt 16	Butt 16
Length of grading section [b] (feet)	Best 12	Best 12	Best 12
D.b.h., minimum (inches)	16[c]	13	11
D.i.b., minimum at top of grading section (inches)	13[c] 16 20	11[d] 12	8
Clear cuttings (on the 3 best faces)[e]			
Length, minimum (feet)	7 5 3	3 3	2
Number on face (maximum)	2	2 3	Unlimited
Yield in face length (minimum)	5/6	4/6	3/6
Cull deduction (including crook and sweep, but excluding shake) maximum within grading section (percent)	9	f	50

[a] Hanks (1976)

[b] Whenever a 14- or 16-foot section of the butt 16-foot log is better than the best 12-foot section, the grade of the longer section will become the grade of the tree. This longer section, when used, is the basis for determining the grading factors such as diameter and cull deduction.

[c] In basswood and ash, d.i.b. at top of grading section must be 12 inches and d.b.h. must be 15 inches.

[d] Grade 2 trees can be 10 inches d.i.b. at top of grading section if they otherwise meet surface requirements for small grade 1's.

[e] A clear cutting is a portion of a face free of defects, extending the width of the face. A face is one-fourth of the surface of the grading section as divided lengthwise.

[f] Fifteen percent crook and sweep or 40 percent total cull deduction are permitted in grade 2 trees, if size and surface of grading section qualify as grade 1. If rot shortens the required clear cuttings to the extent of dropping the butt log to grade 2, do not drop the tree's grade to 3 unless the cull deduction for rot is greater than 40 percent.

Forest Service Standard Specifications for Hardwood Construction Logs (tie and timber logs) [a, b]

Position in tree	Butts and uppers
Minimum diameter, small end	8 inches
Minimum length without trim	8 feet
Clear cuttings	No requirements
Sweep allowance	One-fourth of the diameter at the small end for each 8 feet of length.
Sound surface defects:	
Single knots	Any number, if no one knot has an average diameter above the callus in excess of one-third of the log diameter at point of occurrence.
Whorled knots	Any number, if the sum of knot diameters above the callus does not exceed one-third of the log diameter at point of occurrence.
Holes	Any number, provided none has a diameter over one-third of the log diameter at point of occurrence and none extends more than 3 inches into included timber[c].
Unsound surface defects:	Same requirements as for sound defects if they extend into included timber. No limit if they do not.

[a] Rast et al. (1973).

[b] These specifications are minimum for the class. If, from a group of logs, factory logs are selected first, thus leaving only nonfactory logs from which to select construction logs, then the quality range of the construction logs so selected is limited, and the class may be considered a grade. If selection for construction logs is given first priority, it may be necessary to subdivide the class into grades.

[c] Included timber is always square, and dimension is judged from small end.

Eastern White Pine Saw log Grade Specifications [a]

Grading factor	Log grade 1	Log grade 2	Log grade 3	Log grade 4
1. Minimum scaling diameter (inches)	14[b]	6	6	6
2. Minimum log length (feet)	10[c]	8	8	8
3. Maximum weevil injury (number)	None	None	2 injuries [d]	No limit
4. Minimum face requirements	Two full length or four 50%[e] length good faces (in addition, log knots on balance of faces shall not exceed size limit of grade 2 logs).	**NO GOOD FACES REQUIRED** Maximum diameter of log knots on three best faces: **SOUND RED KNOTS** not to exceed 1/6 scaling diameter and 3" maximum; not to exceed 1/3 scaling diameter and 5" maximum **OVERGROWN/DEAD/BLACK KNOTS** not to exceed 1/12 scaling diameter and 1 1/2" max.; not to exceed 1/6 scaling diameter and 2 1/2" max.		Includes all logs not qualifying for No. 3 or better and having at least 1/3 of their gross volume in sound wood suitable for manufacture into standard lumber
5. Maximum sweep or crook (%)	20	30	40	66 2/3
6. Maximum total scaling deduction (%)	50	50	50	66 2/3

After the tentative grade is established from face examination, the grade will be reduced whenever the following defects are evident:

7. Conks, punk knots, and pine borer damage on bark surface. [f]
   Degrade one grade if present on one face.
   Degrade two grades if present on two faces.
   Degrade three grades if present on three or more faces.

8. Log end defects: red rot, ring shake, heavy stain, and pine borer damage outside the heart center of log. [f] Consider log as having a total of 8 quarters (4 on each end) and degrade as indicated.
   Degrade one grade if present in 2 quarters of log ends.
   Degrade two grades if present in 3 or 4 quarters of log ends.
   Degrade three grades if present in 5 or more quarters of log ends.

a. Ostrander and Brisbin (1971)
b. 12- and 13-inch logs with four full-length good faces are acceptable.
c. 8-foot logs with four full-length good faces are acceptable.
d. 8-foot Number 3 logs limited to one weevil injury.
e. Minimum 50% length good face must be at least 6 feet.
f. Factors 7 and 8 are not cumulative (total degrade based on more serious of the two). No log is to be degraded below grade 4 if net scale is at least one-third of gross scale.

Log Grades for Jack Pine and Red Pine [a]

Grade 1: Trees with three or four clear faces on the 16-foot grading section.[b]
Grade 2: Trees with one or two clear faces on the 16-foot grading section.
Grade 3: Trees with no clear faces on the 16-foot grading section.

After the tentative grade is established from above, the tree will be reduced one grade for each of the following, except that no tree can be reduced below grade 3, provided the total scaling deductions for sweep and/or rot do not exceed two-thirds of the gross scale of the tree.

Sweep. Degrade any tentative grade 1 or 2 tree one grade if sweep in the lower 12 feet of grading sections amounts to 3 or more inches and equals or exceeds one-fourth of the diameter at breast height.

Heart rot. Degrade any tentative grade 1 or 2 tree one grade if conk, punk knots, massed hyphae, or other evidence of advanced heart rot is found anywhere on the main tree stem.

[a] Campbell (1964)

[b] A face is one-fourth of the circumference in width extending full length of the grading section. Clear faces are those free of: knots measuring more than 1/2-inch in diameter, overgrown knots of any size, and holes more than 1/4-inch in diameter. Faces may be rotated to obtain the maximum number of clear on the grading section.

Log Grades for All Other Softwood Logs

Grade 1

1. Trees must be 16 inches in diameter or larger, grading section 12 feet in length or longer, and with deduction for defect not over 30 percent of gross scale.

2. Trees must be at least 75 percent clear on each of three faces.

3. All knots outside clear cutting must be sound and not more than 2-1/2 inches in size.

Grade 2

1. Trees must be 12 inches in diameter or larger, grading section 12 feet in length or longer, and with a net scale after deduction for defect of at least 50 percent of the gross scale deducted for defect.

2. Trees must be at least 50 percent clear on each of three faces or 75 percent clear on two faces.

Grade 3

1. Trees must be 6 inches in diameter or larger, grading section 12 feet in length or longer, and with a net scale after deduction for defect of at least 50 percent of the gross contents of the log.

Note: Diameters are diameter inside bark (d.i.b.) at small end of grading section. Percent clear refers to percent clear in one continuous section.

METRIC EQUIVALENTS OF UNITS USED IN THIS REPORT

1 acre = 4,046.86 square meters or 0.405 hectare.
1,000 acres = 405 hectares.
1 cubic foot = 0.0283 cubic meter.
1 foot = 30.48 centimeters or 0.3048 meter.
1 inch = 25.4 millimeters, 2.54 centimeters, or 0.0254 meter.
1 pound = 0.454 kilograms.
1 ton = 0.907 metric tons.

TREE SPECIES GROUPS IN MICHIGAN
(Little 1981)

Softwoods

Eastern white pine ..... *Pinus strobus*
Red pine ..... *Pinus resinosa*
Jack pine ..... *Pinus banksiana*
White spruce ..... *Picea glauca*
Black spruce ..... *Picea mariana*
Balsam fir ..... *Abies balsamea*
Eastern hemlock ..... *Tsuga canadensis*
Tamarack ..... *Larix laricina*
Northern white-cedar ..... *Thuja occidentalis*
Other softwoods:
- Eastern redcedar ..... *Juniperus virginiana*
- Norway spruce ..... *Picea abies*
- Engelmann spruce ..... *Picea engelmannii*
- Austrian pine ..... *Pinus nigra*
- Scotch pine ..... *Pinus sylvestris*
- Ponderosa pine ..... *Pinus ponderosa*
- Blue spruce ..... *Picea pungens*
- Douglas fir ..... *Pseudotsuga menziesii*

Hardwoods

Select white oaks[1]
- White oak ..... *Quercus alba*
- Bur oak ..... *Quercus macrocarpa*
- Chinkapin oak ..... *Quercus muehlenbergii*
- Swamp white oak ..... *Quercus bicolor*

Other white oaks[1]
- Chestnut oak ..... *Quercus prinus*

Select red oak[1]
- Northern red oak ..... *Quercus rubra*

Other red oaks[1]
- Scarlet oak ..... *Quercus coccinea*
- Northern pin oak ..... *Quercus ellipsoidalis*
- Pin oak ..... *Quercus palustris*
- Black oak ..... *Quercus velutina*

Hickories[1]
- Shagbark hickory ..... *Carya ovata*
- Shellbark hickory ..... *Carya laciniosa*
- Bitternut hickory ..... *Carya cordiformis*
- Mockernut hickory ..... *Carya tomentosa*
- Pignut hickory ..... *Carya glabra*

Hard maples[1]
- Black maple ..... *Acer nigrum*
- Sugar maple ..... *Acer saccharum*

Soft maples[2]
- Red maple ..... *Acer rubrum*
- Silver maple ..... *Acer saccharinum*

American beech[1] ..... *Fagus grandifolia*

Ashes
- White ash[1] ..... *Fraxinus americana*
- Black ash[2] ..... *Fraxinus nigra*
- Green ash[1] ..... *Fraxinus pennsylvanica*

Balsam poplar[2] ..... *Populus balsamifera*

Aspens[2]
- Bigtooth aspen ..... *Populus grandidentata*
- Quaking aspen ..... *Populus tremuloides*

Eastern cottonwood[2] ..... *Populus deltoides*
American basswood[2] ..... *Tilia americana*
Yellow-poplar[2] ..... *Liriodendron tulipifera*
Black walnut[1] ..... *Juglans nigra*
Black cherry[2] ..... *Prunus serotina*
Butternut[2] ..... *Juglans cinerea*
Sycamore[2] ..... *Platanus occidentalis*

Elms
- American elm[2] ..... *Ulmus americana*
- Siberian elm[2] ..... *Ulmus pumila*
- Slippery elm[2] ..... *Ulmus rubra*
- Rock elm[1] ..... *Ulmus thomasii*

Birches
- Yellow birch[1] ..... *Betula alleghaniensis*
- River birch[2] ..... *Betula nigra*
- Paper birch[2] ..... *Betula papyrifera*

Hackberry[2] ..... *Celtis occidentalis*
Black willow[2] ..... *Salix nigr*
Black tupelo[2] ..... *Nyssa sylvatic* var. *sylvatica*

Other hardwoods
- Boxelder[2] ..... *Acer negundo*
- Sweet birch[2] ..... *Betula lenta*
- Black locust[1] ..... *Robinia pseudoacacia*
- Red mulberry[2] ..... *Morus rubra*
- Honeylocust[1] ..... *Gleditsia triacanthos*
- Northern catalpa[2] ..... *Catalpa speciosa*
- Ohio buckeye[2] ..... *Aesculus glabra*
- Flowering dogwood[1] ..... *Cornus florida*
- Sassafras[2] ..... *Sassafras albidum*

Noncommercial species
- Striped maple ..... *Acer pensylvanicum*
- Mountain maple ..... *Acer spicatum*

[1] *This species or species group is considered a hard hardwood, with an average specific gravity greater than or equal to 0.50.*

[2] *This species or species group is considered a soft hardwood, with an average specific gravity of less than 0.50.*

Ailanthus ..... *Ailanthus altissima*
American hornbeam ..... *Carpinus caroliniana*
Hawthorn ..... *Crataegus* spp.
Osage-orange ..... *Maclura pomifera*
Apple ..... *Malus* spp.
Eastern hophornbeam ..... *Ostrya virginiana*
Pincherry ..... *Prunus pensylvanica*
Wild plum ..... *Prunus* spp.
Chokecherry ..... *Prunus virginiana*
Peachleaf willow ..... *Salix amygdaloides*
Diamond willow ..... *Salix bebbiana*
American mountain ash .... *Sorbus americana*

DEFINITION OF TERMS

Average annual mortality of growing stock.—The average cubic foot volume of sound wood in growing-stock trees that died in 1 year. Average annual mortality is the average for the years between inventories (1980 to 1992 in this report).

Average annual mortality of sawtimber.—The average board foot volume of sound wood in sawtimber trees that died in 1 year. Average annual mortality is the average for the years between inventories (1980 to 1992 in this report).

Average annual removals from growing stock.—The average net growing-stock volume in growing-stock trees removed annually for roundwood forest products, in addition to the volume of logging residues, and the volume of other removals. Average annual removals of growing stock are the average for the years between inventories (1980 to 1992 in this report) and are based on information obtained from remeasurement plots (see Survey Procedures in Appendix).

Average annual removals from sawtimber.—The average net board foot sawtimber volume of live sawtimber trees removed annually for roundwood forest products, in addition to the volume of logging residues, and the volume of other removals. Average annual removals of sawtimber are the average for the years between inventories (1980 to 1992 in this report) and are based on information obtained from remeasurement plots (see Survey Procedures in Appendix).

Average net annual growth of growing stock.—The annual change in cubic foot volume of sound wood in live sawtimber and poletimber trees, and the total volume of trees entering these classes through ingrowth, less volume losses resulting from natural causes. Average net annual growing stock is the average for the years between inventories (1980 to 1992 in this report).

Average net annual growth of sawtimber.—The annual change in the board foot volume of live sawtimber trees, and the total volume of trees reaching sawtimber size, less volume losses resulting from natural causes. Average net annual growth of sawtimber is the average for the years between inventories (1980 to 1992 in this report).

Basal area.—Tree area in square feet of the cross section at breast height of a single tree. When the basal areas of all trees in a stand are summed, the result is usually expressed as square feet of basal area per acre.

Biomass.—The aboveground volume of all live trees (including bark but excluding foliage) reported in green tons (i.e., green weight). Biomass has four components:

Bole.—Biomass of a tree from 1 foot above the ground to a 4-inch top outside bark.

Tops and limbs.—Total biomass of tree from a 1-foot stump minus the bole.

1- to 5-inch trees.—Total aboveground biomass of a tree from 1 to 5 inches in diameter at breast height.

Stump.—Biomass of a tree 5 inches d.b.h. and larger from the ground to a height of 1 foot.

Commercial species.—Tree species presently or prospectively suitable for industrial wood products. (Note: Excludes species of typically small size, poor form, or inferior quality such as hophornbeam, Osage-orange, and redbud.)

Cord.—One standard cord is 128 cubic feet of stacked wood, including bark and air space. Cubic feet can be converted to solid wood standard cords by dividing by 79.

Corporate.—Lands owned by a private corporation not in the business of operating primary wood-using plants.

County and municipal land.—Land owned by counties and local public agencies or municipalities, or land leased to these governmental units for 50 years or more.

Cropland.—Land under cultivation within the last 24 months; including cropland harvested, crop failures, cultivated summer fallow, idle cropland used only for pasture, orchards, and land in soil improvement crops, but excluding land cultivated in developing improved pasture.

Cull.—Portions of a tree that are unusable for industrial wood products because of rot, missing or dead material, form, or other defect.

Current annual growth of growing stock.—The annual change in volume of sound wood in live sawtimber and poletimber trees and the total volume of trees entering these classes through ingrowth, less volume losses resulting from natural causes, reported for a single year (1992 in this report). Current growth is based on an estimate of the current annual increment of each growing-stock tree in the inventory.

Current annual growth of sawtimber.—The annual change in the volume of live sawtimber trees, and the total volume of trees reaching sawtimber size, less volume losses resulting from natural causes, reported for a single year (1992 in this report). Current growth is based on an estimate of the current annual increment of each growing-stock tree in the inventory.

Current annual removals from growing stock.—The current net growing-stock volume in growing-stock trees removed annually for roundwood forest products, in addition to the volume of logging residues, and the volume of other removals. Current annual removals of growing stock are reported for a single year (1992 in this report); they are based on a survey of primary wood processing mills to determine removals for products and on information from remeasurement plots (see Survey Procedures in Appendix) to determine removals due to land use change.

Current annual removals from sawtimber.—The current net board foot sawtimber volume of live sawtimber trees removed annually for roundwood forest products, in addition to the volume of logging residues, and the volume of other removals. Current annual removals of sawtimber are reported for a single year (1992 in this report); they are based on a survey of primary wood processing mills to determine removals for products and on information from remeasurement plots (see Survey Procedures in Appendix) to determine removals due to land use change.

Diameter class.—A classification of trees based on diameter outside bark, measured at breast height 4.5 feet above the ground. (Note d.b.h. is the common abbreviation for diameter at breast height.) Two-inch diameter classes are commonly used in Forest Inventory and Analysis, with the even inch the approximate midpoint for a class. For example, the 6-inch class includes trees 5.0 through 6.9 inches d.b.h.

Diameter at breast height (d.b.h.).—The outside bark diameter at 4.5 feet (1.37 m) above the forest floor on the uphill side of the tree. For determining breast height, the forest floor includes the duff layer that may be present, but does not include unincorporated woody debris that may rise above the ground line.

Farm.—Any place from which $1,000 or more of agricultural products were produced and sold during the year.

Farmer-owned land.—(See individual private land.)

Forest industry land.—Land owned by companies or individuals operating primary wood-using plants.

Forest land.—Land at least 16.7 percent stocked by forest trees of any size, or formerly having had such tree cover, and not currently developed for nonforest use. (Note: Stocking is measured by comparing specified standards with basal area and/or number of trees, age or size, and spacing.) The minimum area for classification of forest land is 1 acre. Roadside, streamside, and shelterbelt strips of timber must have a crown width of at least 120 feet to qualify as forest land. Unimproved roads and trails, streams, or other bodies of water or clearings in forest areas shall be classed as forest if less than 120 feet wide. (See Tree, Land, Timberland, Reserved forest land, Other forest land, Stocking, and Water.)

Forest type.—A classification of forest land based on the species forming a plurality of live tree stocking. The associated species for each forest type are based on net volume of growing stock and all live biomass by species group. Major forest types in the State are:

Jack pine.—Forests in which jack pine comprises a plurality of the stocking. Species commonly associated with the jack pine forest type in Michigan include red pine, select red oaks, aspen, and eastern white pine.

Red pine.—Forests in which red pine comprises a plurality of the stocking. Species commonly associated with the red pine forest type in Michigan include eastern white pine, jack pine, and aspen.

Eastern white pine.—Forests in which eastern white pine comprises a plurality of the stocking. Species commonly associated with the eastern white pine forest type in Michigan include red pine, aspen, red maple, paper birch, red oak, white spruce, and balsam fir.

Balsam fir.—Forests in which balsam fir and white spruce comprise a plurality of the stocking, with balsam fir the most common. Species commonly associated with the balsam fir forest type in Michigan include white spruce, aspen, northern white-cedar, paper birch, red maple, black spruce, and eastern white pine.

White spruce.—Forests in which white spruce and balsam fir comprise a plurality of the stocking, with white spruce the most common. Species commonly associated with the white spruce forest type in Michigan include aspen, paper birch, balsam fir, eastern white pine, red maple, and northern white-cedar.

Black spruce.—Forests in which swamp conifers comprise a plurality of the stocking, with black spruce the most common. Species commonly associated with the black spruce forest type in Michigan include tamarack, balsam fir, eastern white pine, northern white-cedar, aspen, jack pine, and paper birch.

Northern white-cedar.—Forests in which swamp conifers comprise a plurality of the stocking, with northern white-cedar the most common. Species commonly associated with the northern white-cedar forest type in Michigan include balsam fir, paper birch, black spruce, red maple, and aspen.

Tamarack.—Forests in which swamp conifers comprise a plurality of the stocking, with tamarack the most common. Species commonly associated with the tamarack forest type in Michigan include northern white-cedar, black spruce, balsam fir, and paper birch.

Oak-hickory.—Forests in which northern red oak, white oak, bur oak, or hickories, singly or in combination, comprise a plurality of the stocking. Species commonly associated with the oak-hickory forest type in Michigan include red maple, aspen, and black cherry.

Elm-ash-soft maple.—Forests in which lowland elm, ash, red maple, silver maple, and cottonwood, singly or in combination, comprise a plurality of the stocking. Species commonly associated with the elm-ash-soft maple forest type in Michigan include northern white-cedar, aspen, cottonwood, and balsam fir.

Maple-beech-birch.—Forests in which sugar maple, yellow birch, American elm, and red maple, singly or in combination, comprise a plurality of the stocking. Species commonly associated with the maple-beech-birch forest type in Michigan include basswood, eastern hemlock, green and white ash, aspen, black cherry, and select red oaks.

Aspen.—Forests in which quaking aspen or bigtooth aspen, singly or in combination, comprise a plurality of the stocking. Species commonly associated with the aspen forest type in Michigan include red maple, paper birch, balsam fir, and select red oaks.

Paper birch.—Forests in which paper birch comprises a plurality of the stocking. Species commonly associated with the paper birch forest type in Michigan include aspen, red maple, balsam fir, northern white-cedar, sugar maple, and balsam poplar.

Balsam poplar.—Forests in which balsam poplar comprises a plurality of the stocking. Species commonly associated with the balsam poplar forest type in Michigan include balsam fir, aspen, northern white-cedar, paper birch, black ash, and white spruce.

Growing-stock tree.—A live tree of commercial species that meets specified standards of size, quality, and merchantability. (Note: Excludes rough, rotten, and dead trees.)

Growing-stock volume.—Net volume in cubic feet of growing-stock trees 5.0 inches d.b.h. and over, from 1 foot above the ground to a

minimum 4.0-inch top diameter outside bark of the central stem or to the point where the central stem breaks into limbs.

Hard hardwoods.—Hardwood species with an average specific gravity greater than 0.50 such as oaks, hard maple, hickories, and ash.

Hardwoods.—Dicotyledonous trees, usually broad-leaved and deciduous. (See Soft hardwoods and Hard hardwoods.)

Improved pasture.—Land currently improved for grazing by cultivating, seeding, irrigating, or clearing trees or brush and less than 16.7 percent stocked with trees.

Indian land.—Land held in trust by the United States for tribes or individual Indians.

Individual private land.—Privately owned land not owned by forest industry. This class includes the formerly used Farmer and Miscellaneous private classes.

Industrial wood.—All roundwood products except residential fuelwood.

Land.— *(a) Bureau of the Census.* Dry land and land temporarily or partly covered by water such as marshes, swamps, and river flood plains (omitting tidal flats below mean high tide); streams, sloughs, estuaries, and canals less than one-eighth of a statute mile wide; and lakes, reservoirs, and ponds less than 40 acres in area.

(b) Forest Inventory and Analysis. The same as the Bureau of the Census, except minimum width of streams, etc., is 120 feet and minimum size of lakes, etc., is 1 acre.

Live trees.—Growing-stock, rough, and rotten trees 1.0 inch d.b.h. and larger.

Log grade.—A log classification based on external characteristics as indicators of quality or value. Log grade was assigned to a sample of softwood sawtimber trees throughout the State during the 1993 inventory. Also see Tree grade. (See Appendix for specific grading factors used.)

Logging residue.—The unused portions of cut trees, plus unused trees killed by logging.

Marsh.—Nonforest land that characteristically supports low, generally herbaceous or shrubby vegetation, and that is intermittently covered with water.

Merchantable.—Refers to a pulpwood or saw-log section that meets pulpwood or saw-log specifications, respectively.

Miscellaneous Federal land.—Federal land other than National Forest and land administered by the Bureau of Land Management or Bureau of Indian Affairs.

Miscellaneous private land.—(See Individual private land.)

National Forest land.—Federal land that has been legally designated as National Forest or purchase units, and other land administered by the USDA Forest Service.

Net volume.—Gross volume less deductions for rot, sweep, or other defect affecting use for timber products.

Noncommercial species.—Tree species of typically small size, poor form, or inferior quality that normally do not develop into trees suitable for industrial wood products.

Nonforest land.—Land that has never supported forests, and land formerly forested where use for timber management is precluded by development for other uses. (Note: Includes areas used for crops, improved pasture, residential areas, city parks, improved roads of any width and adjoining clearings, powerline clearings of any width, and 1- to 40-acre areas of water classified by the Bureau of the Census as land.) If intermingled in forest areas, unimproved roads and nonforest strips must be more than 120 feet wide and more than 1 acre in area to qualify as nonforest land.

Nonforest land without trees.—Nonforest land with no live trees present.

Nonforest land with trees.—Nonforest land with one or more trees per acre at least 5 inches d.b.h.

Nonstocked land.—Timberland less than 16.7 percent stocked with all live trees.

Other forest land.—Forest land not capable of producing 20 cubic feet per acre per year of

industrial wood crops under natural conditions and not associated with urban or rural development. Many of these sites contain tree species that are not currently utilized for industrial wood production or trees of poor form, small size, or inferior quality that are unfit for most industrial products. Unproductivity may be the result of adverse site conditions such as sterile soil, dry climate, poor drainage, high elevation, and rockiness. This land is not withdrawn from timber utilization.

Other removals.—Growing-stock trees removed but not utilized for products, or trees left standing but "removed" from the timberland classification by land use change. Examples are removals from cultural operations such as timber stand improvement work and land clearing, and the standing volume on land classified originally as timberland but later designated as reserved from timber harvesting (such as a newly established State park).

Ownership size class.—The amount of timberland owned by one owner, regardless of the number of parcels.

Pasture.—Land presently used for grazing or under cultivation to develop grazing.

Physiographic class.—A measure of soil and water conditions that affect tree growth on a site. The physiographic classes are:

Xeric sites.—Very dry soils where excessive drainage seriously limits both growth and species occurrence. Example: sandy jack pine plains.

Xeromesic sites.—Moderately dry soils where excessive drainage limits growth and species occurrence to some extent. Example: dry oak ridge.

Mesic sites.—Deep, well-drained soils. Growth and species occurrence are limited only by climate. Example: well-drained terraces of loamy soil.

Hydromesic sites.—Moderately wet soils where insufficient drainage or infrequent flooding limits growth and species occurrence to some extent. Example: moderately drained bottomland hardwood sites.

Hydric sites.—Very wet sites where excess water seriously limits both growth and species occurrence. Example: frequently flooded river bottoms and black spruce swamps.

Plant byproducts.—Plant residues used for products such as mulch, pulp chips, and fuelwood.

Plantation.—An artificially reforested area sufficiently productive to qualify as timberland. The planted species is not necessarily predominant. Christmas tree plantations, which are considered reserved forest land, are not included.

Plant residues.—Wood and bark materials generated at manufacturing plants during production of other products.

Poletimber stand.—(See Stand-size class.)

Poletimber tree.—A live tree of commercial species at least 5.0 inches d.b.h., but smaller than sawtimber size.

Potential productivity class.—A classification of forest land in terms of inherent capacity to grow crops of industrial wood. The class identifies the potential growth in merchantable cubic feet/acre/year at culmination of mean annual increment of fully stocked natural stands.

Reserved forest land.—Forest land withdrawn from timber utilization through statute, administrative regulation, designation, or exclusive use for Christmas tree production, as indicated by annual shearing.

Rotten tree.—Live trees of commercial species that do not contain at least one 12-foot saw log or two saw logs 8 feet or longer, now or prospectively, and/or do not meet regional specifications for freedom from defect primarily because of rot; that is, when more than 50 percent of the cull volume in a tree is rotten.

Rough tree.—(a) Live trees of commercial species that do not contain at least one merchantable 12-foot saw log or two saw logs 8 feet or longer, now or prospectively, and/or do not meet regional specifications for freedom from defect primarily because of roughness or poor form, and (b) all live trees of noncommercial species.

Roundwood products.—Logs, bolts, or other round sections (including chips from roundwood) cut from trees for industrial or consumer uses. (Note: Includes saw logs,

veneer logs, and bolts; cooperage logs and bolts; pulpwood; fuelwood; pilings; poles; posts; hewn ties; mine timbers; and various other round, split, or hewn products.)

Salvable dead tree.—A standing or down dead tree considered merchantable by regional standards.

Sapling.—A live tree 1.0 to 5.0 inches d.b.h.

Sapling-seedling stand.—(See Stand-size class.)

Saw log.—A log meeting minimum standards of diameter, length, and defect, including logs at least 8 feet long, sound and straight and with a minimum diameter outside bark (d.o.b.) for softwoods of 7.0 inches (9.0 inches for hardwoods) or other combinations of size and defect specified by regional standards.

Saw-log portion.—That part of the bole of sawtimber trees between the stump and the saw-log top.

Saw-log top.—The point on the bole of sawtimber trees above which a saw log cannot be produced. The minimum saw-log top is 7.0 inches d.o.b. for softwoods and 9.0 inches d.o.b. for hardwoods.

Sawtimber stand.—(See Stand-size class.)

Sawtimber tree.—A live tree of commercial species containing at least a 12-foot saw log or two noncontiguous saw logs 8 feet or longer, and meeting regional specifications for freedom from defect. Softwoods must be at least 9.0 inches d.b.h. Hardwoods must be at least 11.0 inches d.b.h.

Sawtimber volume.—Net volume of the saw-log portion of live sawtimber in board feet, International 1/4-inch rule (unless specified otherwise), from stump to a minimum 7.0 inches top d.o.b. for softwoods and a minimum 9.0 inches top d.o.b. for hardwoods.

Seedling.—A live tree less than 1.0 inch d.b.h. that is expected to survive. Only softwood seedlings more than 6 inches tall and hardwood seedlings more than 1 foot tall are counted.

Short-log (rough tree).—A sawtimber-size tree of commercial species that contains at least one merchantable 8- to 11-foot saw log but not a 12-foot saw log.

Shrub.—A woody, perennial plant differing from a perennial herb in its persistent and woody stem(s) and less definitely from a tree in its lower stature and/or the general absence of a well-defined main stem. For this report, shrubs were separated somewhat arbitrarily into tall and low shrubs as follows:

Tall shrubs.—Normally taller than 1.6 to 3.2 feet.

Low shrubs.—Normally shorter than 1.6 to 3.2 feet. (Woody perennial vines, such as grape, were included with low shrubs.)

Shrub and tree seedling biomass.—The total aboveground weight of trees less than 1.0 inch in diameter and all shrubs.

Site index.—An expression of forest site quality based on the height of a free-growing dominant or codominant tree of a representative species in the forest type at age 50.

Soft hardwoods.—Hardwood species with an average specific gravity less than 0.50, such as cottonwood, red maple, basswood, and willow.

Softwoods.—Coniferous trees, usually evergreen, having needles or scale-like leaves.

Stand.—A group of trees on a minimum of 1 acre of forest land that is stocked by forest trees of any size.

Stand-age class.—A classification based on age of the main stand. Main stand refers to trees of the dominant forest type and stand-size class.

Stand-size class.—A classification of stocked (see Stocking) forest land based on the size class of live trees on the area; that is, sawtimber, poletimber, or seedlings and saplings.

Sawtimber stands.—Stands with half or more of live tree stocking in sawtimber or poletimber trees, and with sawtimber stocking at least equal to poletimber stocking.

Poletimber stands.—Stands with half or more of live tree stocking in poletimber and/or sawtimber trees, and with poletimber stocking exceeding that of sawtimber.

Sapling-seedling stands.—Stands with more than half of the live tree stocking in saplings and/or seedlings.

State land.—Land owned by the State of Michigan or leased to it for 50 years or more.

Stocking.—The degree of occupancy of land by live trees, measured by basal area and/or the number of trees in a stand by size or age and spacing, compared to the basal area and/or number of trees required to fully utilize the growth potential of the land; that is, the stocking standard. A stocking percent of 100 indicates full utilization of the site and is equivalent to 80 square feet of basal area per acre in trees 5.0 inches d.b.h. and larger. In a stand of trees less than 5 inches d.b.h., a stocking percent of 100 would indicate that the present number of trees is sufficient to produce 80 square feet of basal area per acre when the trees reach 5 inches d.b.h.

Stands are grouped into the following stocking classes:

Overstocked stands.—Stands in which stocking of live trees is 133.0 percent or more.

Fully stocked stands.—Stands in which stocking of live trees is from 100.0 to 132.9 percent.

Medium stocked stands.—Stands in which stocking of live trees is from 60.0 to 99.9 percent.

Poorly stocked stands.—Stands in which stocking of live trees is from 16.7 to 59.9 percent.

Nonstocked areas.—Timberland on which stocking of live trees is less than 16.7 percent.

Timber products output.—All timber products cut from roundwood and byproducts of wood manufacturing plants. Roundwood products include logs, bolts, or other round sections cut from growing-stock trees, cull trees, salvable dead trees, trees on nonforest land, noncommercial species, sapling-size trees, and limbwood. Byproducts from primary manufacturing plants include slabs, edging, trimmings, miscuts, sawdust, shavings, veneer cores and clippings, and screenings of pulpmills that are used as pulpwood chips or other products.

Timberland.—Forest land that is producing, or is capable of producing, more than 20 cubic feet per acre per year of industrial wood crops under natural conditions, that is not withdrawn from timber utilization, and that is not associated with urban or rural development. Currently inaccessible and inoperable areas are included. (Timberland was formerly called commercial forest land.)

Tree.—A woody plant usually having one or more perennial stems, a more or less definitely formed crown of foliage, and a height of at least 12 feet at maturity.

Tree biomass.—The total aboveground weight (including the bark but excluding the foliage) of all trees from 1 to 5 inches in d.b.h., and the total aboveground weight (including the bark but excluding the foliage) from a 1-foot stump for trees more than 5 inches in diameter.

Tree grade.—A classification of the lower 16 feet of the bole of standing trees based on external characteristics as indicators of the quality and quantity of lumber that could be produced from the tree. Tree grade was assigned to a sample of hardwood sawtimber trees during the 1993 inventory. Also see Log grade. (See Appendix for specific grading factors used.)

Tree size class.—A classification of trees based on diameter at breast height, including sawtimber trees, poletimber trees, saplings, and seedlings.

Upper stem portion.—That part of the bole of sawtimber trees above the saw-log top to a minimum top diameter of 4.0 inches d.o.b. or to the point where the central stem breaks into limbs.

Urban and other areas.—Areas within the legal boundaries of cities and towns; suburban areas developed for residential, industrial, or recreational purposes; school yards; cemeteries; roads; railroads; airports; beaches; powerlines and other rights-of-way; or other nonforest land not included in any other specified land use class.

Urban forest land.—Land that would otherwise meet the criteria for timberland, but that is in an urban-suburban area surrounded by commercial, industrial, or

residential development and not likely to be managed for the production of industrial wood products on a continuing basis. Wood removed would be for land clearing, fuelwood, or esthetic purposes. Such forest land may be associated with industrial, commercial, residential subdivision, industrial parks, golf course perimeters, airport buffer strips, and public urban parks that qualify as forest land.

Water.—*(a) Bureau of the Census.*—Permanent inland water surfaces, such as lakes, reservoirs, and ponds at least 40 acres in area; and streams, sloughs, estuaries, and canals at least one-eighth of a statute mile wide.

(b) Noncensus.—Permanent inland water surfaces, such as lakes, reservoirs, and ponds from 1 to 39.9 acres in area; and streams, sloughs, estuaries, and canals from 120 feet to one-eighth of a statute mile wide.

Wooded pasture.—Improved pasture with more than 16.7 percent stocking in live trees, but less than 25 percent stocking in growing-stock trees. Area is currently improved for grazing or there is other evidence of grazing.

Wooded strip.—An acre or more of natural continuous forest land that would otherwise meet survey standards for timberland except that it is less than 120 feet wide.

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Table 1. -- Area of land by Forest Survey Unit, county, and major land-use class, Michigan, 1993

(In thousand acres)

Forest Survey Unit and county	Total [1] land area	Forest land				Other [2] land
		Total forest	Timberland	Reserved forest land	Other forest land	
Eastern Upper Peninsula						
Alger	587.5	531.6	471.4	53.6	6.6	55.9
Chippewa	999.1	749.0	707.7	27.1	14.2	250.1
Delta	748.9	602.2	595.5	1.5	5.2	146.7
Luce	578.0	472.7	463.4	3.2	6.1	105.3
Mackinac	653.8	555.4	522.2	26.1	7.1	98.4
Menominee	667.9	524.6	523.3	1.3	-	143.3
Schoolcraft	754.0	540.5	525.4	8.1	7.0	213.5
Total	4,989.2	3,976.0	3,808.9	120.9	46.2	1,013.2
Western Upper Peninsula						
Baraga	578.7	508.3	486.7	19.3	2.3	70.4
Dickinson	490.5	398.2	398.2	-	-	92.3
Gogebic	705.2	635.3	608.4	26.9	-	69.9
Houghton	647.5	540.4	528.9	9.9	1.6	107.1
Iron	746.6	662.3	658.0	-	4.3	84.3
Keweenaw	346.4	312.1	198.5	112.3	1.3	34.3
Marquette	1,165.6	1,027.4	1,005.1	14.3	8.0	138.2
Ontonagon	839.4	752.5	705.6	46.9	-	86.9
Total	5,519.9	4,836.5	4,589.4	229.6	17.5	683.4
Northern Lower Peninsula						
Alcona	431.7	333.0	321.9	9.0	2.1	98.7
Alpena	367.5	236.2	233.0	3.2	-	131.3
Antrim	305.2	189.7	189.7	-	-	115.5
Arenac	234.8	121.1	121.1	-	-	113.7
Bay	284.3	44.2	43.3	0.9	-	240.1
Benzie	205.7	146.6	136.9	9.7	-	59.1
Charlevoix	266.8	172.2	170.4	1.8	-	94.6
Cheboygan	458.0	350.3	339.6	9.8	0.9	107.7
Clare	362.8	245.5	245.5	-	-	117.3
Crawford	357.2	308.1	290.0	18.1	-	49.1
Emmet	299.5	208.1	197.6	8.2	2.3	91.4
Gladwin	324.4	186.9	186.9	-	-	137.5
Grand Traverse	297.7	175.8	170.9	2.7	2.2	121.9
Iosco	351.5	244.4	242.6	-	1.8	107.1
Isabella	367.6	101.6	101.6	-	-	266.0
Kalkaska	359.1	271.1	267.4	3.7	-	88.0
Lake	363.3	315.2	315.2	-	-	48.1
Leelanau	223.0	126.9	88.4	38.5	-	96.1
Manistee	348.1	253.3	249.1	4.2	-	94.8
Mason	316.9	172.7	157.0	12.9	2.8	144.2
Mecosta	355.7	163.4	163.4	-	-	192.3
Midland	333.6	175.6	175.6	-	-	158.0
Missaukee	362.7	237.9	229.3	6.9	1.7	124.8
Montmorency	350.5	293.8	293.6	0.2	-	56.7
Newaygo	539.2	331.5	330.4	1.1	-	207.7
Oceana	345.9	186.9	182.0	4.9	-	159.0
Ogemaw	361.2	229.1	228.5	0.6	-	132.1
Osceola	362.3	185.6	185.6	-	-	176.7
Oscoda	361.6	317.2	307.9	9.3	-	44.4
Otsego	329.3	239.6	239.6	-	-	89.7
Presque Isle	422.4	311.4	298.8	1.6	11.0	111.0
Roscommon	333.7	258.0	254.8	1.5	1.7	75.7
Wexford	362.0	281.7	259.3	22.4	-	80.3
Total	11,345.2	7,414.6	7,216.9	171.2	26.5	3,930.6

(Table 1 continued on next page)

(Table 1 continued)

Forest Survey Unit and county	Total[1] land area	Forest land				Other[2] land
		Total forest	Timberland	Reserved forest land	Other forest land	
Southern Lower Peninsula						
Allegan	529.6	179.9	178.4	1.5	-	349.7
Barry	355.9	111.2	111.2	-	-	244.7
Berrien	365.5	68.3	67.0	1.3	-	297.2
Branch	324.9	54.4	54.4	-	-	270.5
Calhoun	453.7	111.0	110.6	0.4	-	342.7
Cass	315.0	76.9	76.9	-	-	238.1
Clinton	365.7	55.4	53.8	1.6	-	310.3
Eaton	369.0	82.1	82.1	-	-	286.9
Genesee	409.4	64.9	64.9	-	-	344.5
Gratiot	364.9	49.2	49.2	-	-	315.7
Hillsdale	383.3	74.1	74.1	-	-	309.2
Huron	535.4	66.2	64.5	1.7	-	469.2
Ingham	357.9	62.0	62.0	-	-	295.9
Ionia	366.9	74.6	74.6	-	-	292.3
Jackson	452.3	82.3	82.3	-	-	370.0
Kalamazoo	359.6	79.0	75.0	4.0	-	280.6
Kent	548.0	155.5	155.5	-	-	392.5
Lapeer	418.8	110.3	109.4	0.9	-	308.5
Lenawee	480.4	55.2	55.2	-	-	425.2
Livingston	363.8	100.0	94.1	5.9	-	263.8
Macomb	307.5	61.4	60.6	0.8	-	246.1
Monroe	352.7	37.9	37.9	-	-	314.8
Montcalm	453.2	133.0	133.0	-	-	320.2
Muskegon	325.9	162.2	159.9	2.3	-	163.7
Oakland	558.5	137.4	111.2	26.2	-	421.1
Ottawa	362.1	79.1	79.1	-	-	283.0
Saginaw	517.7	98.9	98.9	-	-	418.8
St. Clair	463.6	79.7	78.3	1.4	-	383.9
St. Joseph	322.4	65.6	65.6	-	-	256.8
Sanilac	616.9	79.9	79.9	-	-	537.0
Shiawassee	344.9	50.2	50.2	-	-	294.7
Tuscola	520.1	115.5	115.5	-	-	404.6
Van Buren	391.0	122.3	122.3	-	-	268.7
Washtenaw	454.4	82.2	82.2	-	-	372.2
Wayne	393.0	35.9	30.9	5.0	-	357.1
Total	14,503.9	3,053.7	3,000.7	53.0	-	11,450.2
All counties	36,358.2	19,280.8	18,615.9	574.7	90.2	17,077.4

[1] From U. S. Bureau of the Census, 1990.

[2] Includes 183.5 thousand acres of water according to FIA standards of area classification, but defined by the Bureau of the Census as land.

Table 2. -- Area of timberland by Forest Survey Unit, county, and ownership class, Michigan, 1993

(In thousand acres)

Forest Survey Unit and county	All ownerships	National forest	Other federal	State	County and municipal	Indian	Forest industry	Individual	Corporate
Eastern Upper Peninsula									
Alger	471.4	105.3	4.0	81.3	-	-	33.6	90.8	156.4
Chippewa	707.7	210.4	0.9	155.8	1.1	1.3	57.4	227.9	52.9
Delta	595.5	218.9	1.5	61.7	4.9	-	68.4	220.0	20.1
Luce	463.4	-	-	215.4	-	-	84.0	115.6	48.4
Mackinac	522.2	123.6	-	165.1	1.7	-	20.6	166.6	44.6
Menominee	523.3	-	-	72.6	2.3	6.9	118.1	303.8	19.6
Schoolcraft	525.4	105.7	14.1	185.3	2.7	-	40.3	117.2	60.1
Total	3,808.9	763.9	20.5	937.2	12.7	8.2	422.4	1,241.9	402.1
Western Upper Peninsula									
Baraga	486.7	33.7	10.1	57.9	1.3	6.4	252.4	101.0	23.9
Dickinson	398.2	-	1.6	195.9	4.0	-	38.6	123.3	34.8
Gogebic	608.4	267.1	-	2.7	57.7	-	123.7	91.0	66.2
Houghton	528.9	141.5	-	40.3	5.8	-	89.6	150.1	101.6
Iron	658.0	169.0	-	73.8	3.1	-	95.9	162.8	153.4
Keweenaw	198.5	-	1.3	1.2	-	-	160.3	19.7	16.0
Marquette	1,005.1	5.0	1.4	224.5	14.2	-	171.4	295.4	293.2
Ontonagon	705.6	247.1	2.7	20.4	3.9	-	153.8	133.4	144.3
Total	4,589.4	863.4	17.1	616.7	90.0	6.4	1,085.7	1,076.7	833.4
Northern Lower Peninsula									
Alcona	321.9	101.8	-	2.1	6.6	-	-	164.3	47.1
Alpena	233.0	-	-	36.8	2.4	-	-	156.0	37.8
Antrim	189.7	-	-	51.1	6.4	-	-	121.7	10.5
Arenac	121.1	-	-	34.3	1.8	-	-	81.5	3.5
Bay	43.3	-	-	- -	-	-	-	43.3	-
Benzie	136.9	-	-	66.5	-	-	-	62.4	8.0
Charlevoix	170.4	-	-	62.3	-	-	-	92.5	15.6
Cheboygan	339.6	-	-	168.2	-	-	-	154.1	17.3
Clare	245.5	-	4.1	53.3	-	-	-	158.1	30.0
Crawford	290.0	35.9	2.1	151.9	-	-	-	95.8	4.3
Emmet	197.6	-	-	75.1	4.9	-	-	108.1	9.5
Gladwin	186.9	-	-	75.4	4.4	-	-	104.0	3.1
Grand Traverse	170.9	-	-	70.6	4.4	-	-	89.3	6.6
Iosco	242.6	107.8	-	15.2	-	-	-	98.7	20.9
Isabella	101.6	-	-	3.2	-	-	-	93.9	4.5
Kalkaska	267.4	-	-	144.1	-	-	-	105.6	17.7
Lake	315.2	111.9	1.7	63.5	-	-	-	125.0	13.1
Leelanau	88.4	-	-	5.9	-	-	-	77.2	5.3
Manistee	249.1	82.1	-	15.0	10.7	-	-	110.9	30.4
Mason	157.0	47.8	-	7.0	3.4	-	5.6	85.4	7.8
Mecosta	163.4	-	-	20.7	7.1	-	-	129.8	5.8
Midland	175.6	-	-	47.0	1.6	-	0.6	119.3	7.1
Missaukee	229.3	-	-	106.6	-	-	-	99.6	23.1
Montmorency	293.6	-	-	148.1	-	-	-	123.9	21.6
Newaygo	330.4	107.0	-	4.0	2.3	-	-	208.5	8.6
Oceana	182.0	52.7	-	1.8	2.3	-	-	111.2	14.0
Ogemaw	228.5	20.1	-	65.9	5.1	-	-	118.9	18.5
Osceola	185.6	-	-	20.9	1.7	-	-	149.4	13.6
Oscoda	307.9	141.2	-	42.4	-	-	-	77.1	47.2
Otsego	239.6	-	1.9	82.2	-	-	-	130.1	25.4
Presque Isle	298.8	-	2.2	66.0	1.2	-	-	183.9	45.5
Roscommon	254.8	-	-	168.3	1.7	-	-	52.8	32.0
Wexford	259.3	92.6	-	60.9	-	-	-	94.5	11.3
Total	7,216.9	900.9	12.0	1,936.3	68.0	-	6.2	3,726.8	566.7

(Table 2 continued on next page)

(Table 2 continued)

Forest Survey Unit and county	All ownerships	National forest	Other federal	State	County and municipal	Indian	Forest industry	Individual	Corporate
Southern Lower Peninsula									
Allegan	178.4	-	-	55.8	-	-	-	114.6	8.0
Barry	111.2	-	-	19.8	-	-	-	91.4	-
Berrien	67.0	-	-	2.7	9.6	-	-	49.3	5.4
Branch	54.4	-	-	-	3.0	-	-	51.4	-
Calhoun	110.6	-	-	-	-	-	-	103.0	7.6
Cass	76.9	-	-	-	-	-	-	68.8	8.1
Clinton	53.8	-	-	-	2.6	-	-	43.8	7.4
Eaton	82.1	-	-	-	-	-	-	53.2	28.9
Genesee	64.9	-	-	-	3.7	-	-	61.2	-
Gratiot	49.2	-	-	7.3	-	-	-	41.9	-
Hillsdale	74.1	-	-	-	-	-	-	74.1	-
Huron	64.5	-	-	9.7	2.8	-	-	52.0	-
Ingham	62.0	-	-	3.6	-	-	-	54.7	3.7
Ionia	74.6	-	-	4.0	3.8	-	-	66.8	-
Jackson	82.3	-	-	13.1	2.6	-	-	58.5	8.1
Kalamazoo	75.0	-	-	6.2	5.8	-	-	63.0	-
Kent	155.5	-	-	1.5	-	-	-	145.7	8.3
Lapeer	109.4	-	-	15.8	2.9	-	-	80.3	10.4
Lenawee	55.2	-	-	-	-	-	-	53.0	2.2
Livingston	94.1	-	-	5.6	-	-	-	70.9	17.6
Macomb	60.6	-	-	2.4	9.0	-	-	19.7	29.5
Monroe	37.9	-	-	1.5	-	-	-	30.1	6.3
Montcalm	133.0	1.8	-	18.5	5.9	-	-	96.5	10.3
Muskegon	159.9	12.4	-	8.8	21.8	-	-	101.4	15.5
Oakland	111.2	-	-	-	-	-	-	79.2	32.0
Ottawa	79.1	-	-	-	5.1	-	-	65.0	9.0
Saginaw	98.9	-	-	9.6	-	-	-	89.3	-
St. Clair	78.3	-	-	11.0	-	-	-	51.1	16.2
St. Joseph	65.6	-	-	4.6	-	-	-	61.0	-
Sanilac	79.9	-	-	2.9	-	-	-	68.3	8.7
Shiawassee	50.2	-	-	-	-	-	-	47.2	3.0
Tuscola	115.5	-	-	21.2	-	-	-	94.3	-
Van Buren	122.3	-	-	-	1.1	-	-	117.9	3.3
Washtenaw	82.2	-	-	12.4	3.5	-	-	59.5	6.8
Wayne	30.9	-	-	-	2.4	-	-	25.0	3.5
Total	3,000.7	14.2	-	238.0	85.6	-	-	2,403.1	259.8
All counties	18,615.9	2,542.4	49.6	3,728.2	256.3	14.6	1,514.3	8,448.5	2,062.0

Table 3. -- Area of timberland by Forest Survey Unit, county, and forest type group/local type, Michigan, 1993

(In thousand acres)

Forest Survey Unit and county	All types	Forest type group/local type																	
		White-red-jack pine				Spruce-fir						Oak-hickory	Elm-ash-cottonwood	Maple-beech-birch	Aspen-birch				Non-stocked
		Total	Jack pine	Red pine	White pine	Total	Balsam fir	White spruce	Black spruce	Northern white-cedar	Tamarack	Oak-hickory	Elm-ash-soft maple	Maple-beech-birch	Total	Aspen	Paper birch	Balsam poplar	Non-stocked
Eastern Upper Peninsula																			
Alger	471.4	50.7	8.2	28.4	14.1	65.0	13.4	5.3	11.6	34.7	-	-	20.2	314.4	19.0	16.4	1.3	1.3	2.1
Chippewa	707.7	104.4	70.1	23.3	11.0	216.4	47.9	17.5	46.9	89.7	14.4	16.4	38.9	168.2	163.4	129.0	14.4	20.0	-
Delta	595.5	45.1	14.8	28.3	2.0	233.0	51.9	13.8	35.5	124.8	7.0	7.5	40.6	138.3	131.0	87.9	7.8	35.3	-
Luce	463.4	76.7	45.5	19.0	12.2	126.6	10.5	-	43.9	65.1	7.1	3.0	18.6	201.9	33.9	30.1	2.1	1.7	2.7
Mackinac	522.2	49.0	9.8	29.8	9.4	202.2	47.8	15.4	27.6	107.9	3.5	-	22.5	129.0	117.1	73.9	19.7	23.5	2.4
Menominee	523.3	13.1	1.2	3.4	8.5	201.6	34.8	6.7	19.6	126.0	14.5	6.5	56.9	138.8	105.3	70.4	21.1	13.8	1.1
Schoolcraft	525.4	82.3	45.4	26.0	10.9	169.5	26.3	3.4	47.1	84.7	8.0	4.2	23.0	173.7	72.7	52.6	13.4	6.7	--
Total	3,808.9	421.3	195.0	158.2	68.1	1,214.3	232.6	62.1	232.2	632.9	54.5	37.6	220.7	1,264.3	642.4	460.3	79.8	102.3	8.3
Western Upper Peninsula																			
Baraga	486.7	12.1	7.2	3.6	1.3	96.4	31.8	1.0	24.9	32.8	5.9	0.6	17.3	320.4	39.9	33.8	5.0	1.1	-
Dickinson	398.2	16.9	3.0	6.3	7.6	127.2	40.5	4.0	25.6	53.9	3.2	4.2	15.7	114.8	119.4	99.4	7.6	12.4	-
Gogebic	608.4	17.9	-	17.9	-	95.1	35.5	9.7	10.8	29.3	9.8	2.7	49.4	376.8	64.8	60.9	3.9	-	1.7
Houghton	528.9	30.6	13.3	15.7	1.6	53.1	20.1	5.4	4.6	16.6	6.4	2.4	22.3	361.7	58.8	51.0	7.8	-	-
Iron	658.0	30.9	1.2	18.7	11.0	158.1	58.8	8.7	49.4	25.0	16.2	2.9	4.8	307.3	154.0	123.1	23.4	7.5	-
Keweenaw	198.5	3.5	-	-	3.5	63.1	11.9	4.9	5.2	41.1	-	4.2	5.6	95.1	27.0	13.5	13.5	-	-
Marquette	1,005.1	94.5	62.6	19.9	12.0	231.6	52.1	9.4	79.1	84.1	6.9	10.7	46.8	454.6	161.9	127.1	31.5	3.3	5.0
Ontonagon	705.6	24.9	-	15.7	9.2	42.4	17.2	8.1	8.6	8.5	-	1.3	27.1	435.1	174.8	167.8	5.2	1.8	-
Total	4,589.4	231.3	87.3	97.8	46.2	867.0	267.9	51.2	208.2	291.3	48.4	29.0	189.0	2,465.8	800.6	676.6	97.9	26.1	6.7
Northern Lower Peninsula																			
Alcona	321.9	33.6	8.0	20.8	4.8	51.2	6.2	5.4	2.6	34.9	2.1	88.7	8.4	39.2	100.4	88.4	2.1	9.9	0.4
Alpena	233.0	18.6	7.4	7.1	4.1	53.6	13.3	2.4	-	36.8	1.1	8.1	27.2	36.8	87.0	66.7	14.9	5.4	1.7
Antrim	189.7	14.0	6.8	7.2	-	15.2	-	-	-	15.2	-	-	6.1	126.4	28.0	28.0	--	-	-
Arenac	121.1	5.0	5.0	-	-	2.8	1.8	1.0	-	-	-	26.6	25.2	23.4	38.1	35.2	2.9	-	-
Bay	43.3	-	-	-	-	-	-	-	-	-	-	-	19.6	8.4	15.3	15.3	-	-	-
Benzie	136.9	17.0	3.3	13.7	-	5.6	-	2.3	-	-	3.3	-	12.2	93.0	9.1	9.1	-	-	-
Charlevoix	170.4	16.6	-	7.8	8.8	30.3	2.1	-	-	19.3	8.7	-	6.2	107.3	10.0	5.3	4.7	-	-
Cheboygan	339.6	36.6	17.5	16.8	2.3	34.7	2.7	1.2	2.3	28.5	-	14.9	16.2	122.1	115.1	107.5	3.6	4.0	-
Clare	245.5	39.9	24.5	15.4	-	5.3	-	-	-	3.8	1.5	46.3	33.4	57.1	63.5	63.5	-	-	-
Crawford	290.0	108.2	89.3	16.8	2.1	16.7	-	-	10.3	6.4	-	73.4	2.2	42.7	46.8	40.4	4.3	2.1	-
Emmet	197.6	14.6	7.0	7.6	-	15.2	1.3	1.7	-	12.2	-	1.8	10.2	118.8	37.0	31.1	5.9	-	-
Gladwin	186.9	8.0	1.9	6.1	-	-	-	-	-	-	-	26.2	29.6	33.7	89.4	80.0	-	9.4	-
Grand Traverse	170.9	51.9	13.3	36.4	2.2	9.2	-	-	-	7.0	2.2	30.8	4.4	42.3	32.3	27.9	4.4	-	-
Iosco	242.6	89.2	40.5	42.3	6.4	27.0	-	-	-	21.8	5.2	23.8	25.4	30.7	46.5	35.3	4.6	6.6	-
Isabella	101.6	7.0	4.0	2.5	0.5	2.4	-	-	-	2.4	-	15.3	14.0	25.1	37.8	35.7	2.1	-	-
Kalkaska	267.4	65.9	26.8	37.1	2.0	17.7	2.0	-	-	15.7	-	12.1	-	121.4	47.8	44.7	3.1	-	2.5
Lake	315.2	74.7	21.3	44.7	8.7	8.3	-	-	-	8.3	-	150.9	9.2	42.4	29.7	29.7	-	-	-
Leelanau	88.4	17.0	-	10.9	6.1	4.9	-	-	-	4.9	-	-	3.4	55.1	8.0	5.7	2.3	-	-
Manistee	249.1	47.4	10.6	32.9	3.9	4.8	-	-	-	4.8	-	53.5	23.5	88.6	31.3	29.8	1.5	-	-
Mason	157.0	34.1	8.8	24.7	0.6	-	-	-	-	-	-	54.0	22.8	23.6	22.5	22.5	-	-	-
Mecosta	163.4	11.0	4.3	5.5	1.2	5.1	-	1.3	-	3.8	-	13.5	23.9	71.5	38.4	36.8	1.6	-	-
Midland	175.6	0.6	-	-	0.6	-	-	-	-	-	-	27.9	38.7	49.3	59.1	53.3	5.8	-	-
Missaukee	229.3	29.8	12.8	17.0	-	25.6	-	3.0	-	18.6	4.0	27.8	28.6	57.1	60.4	58.9	1.5	-	-
Montmorency	293.6	43.5	23.0	18.6	1.9	28.6	7.5	1.6	-	16.7	2.8	47.7	8.7	88.9	72.3	68.3	2.0	-	3.9
Newaygo	330.4	53.4	13.6	29.4	10.4	1.3	-	-	-	-	1.3	127.6	43.2	85.8	19.1	19.1	-	-	-
Oceana	182.0	25.2	6.3	18.9	-	6.3	-	-	-	6.3	-	56.6	22.9	50.9	19.3	19.3	-	-	0.8
Ogemaw	228.5	50.5	31.0	16.6	2.9	17.1	1.7	-	-	15.4	-	27.7	12.9	52.0	68.3	58.3	10.0	-	-
Osceola	185.6	17.8	6.1	11.7	-	12.2	-	-	-	12.2	-	8.0	12.3	82.9	50.2	49.0	1.2	-	2.2
Oscoda	307.9	104.4	62.7	27.8	13.9	13.3	2.7	-	1.6	6.6	2.4	67.6	3.2	47.7	69.6	66.5	3.1	-	2.1
Otsego	239.6	39.5	13.8	19.8	5.9	20.1	4.0	1.9	1.8	12.4	-	13.5	2.0	130.6	31.8	25.9	3.9	2.0	2.1
Presque Isle	298.8	33.6	15.7	15.9	2.0	79.0	8.1	2.0	2.3	64.2	2.4	25.5	21.3	48.9	89.3	61.2	15.1	13.0	1.2
Roscommon	254.8	32.5	18.2	12.2	2.1	40.2	9.2	-	-	31.0	-	83.6	15.2	30.1	53.2	51.4	1.8	-	-
Wexford	259.3	67.2	17.1	47.6	2.5	16.0	-	1.2	3.6	10.0	1.2	15.4	13.8	96.5	50.4	46.0	4.4	-	-
Total	7,216.9	1,208.3	520.6	591.8	95.9	569.7	62.6	25.0	24.7	419.2	38.2	1,168.8	545.9	2,130.3	1,577.0	1,415.8	106.8	54.4	16.9

(Table 3 continued on next page)

(Table 3 continued)

Forest Survey Unit and county	All types	Forest type group/local type																	
		White-red-jack pine				Spruce-fir						Oak-hickory	Elm-ash-cottonwood	Maple-beech-birch	Aspen-birch				Non-stocked
		Total	Jack pine	Red pine	White pine	Total	Balsam fir	White spruce	Black spruce	Northern white-cedar	Tamarack	Oak-hickory	Elm-ash-soft maple	Maple-beech-birch	Total	Aspen	Paper birch	Balsam poplar	Non-stocked
Southern Lower Peninsula																			
Allegan	178.4	7.7	4.6	0.6	2.5	-	-	-	-	-	-	71.3	27.8	67.6	4.0	4.0	--	--	--
Barry	111.2	2.2	2.2	-	-	1.1	-	1.1	-	-	-	44.7	13.0	50.2	--	--	--	--	--
Berrien	67.0	4.0	4.0	-	-	-	-	-	-	-	-	16.8	15.0	31.2	--	--	--	--	--
Branch	54.4	-	-	-	-	-	-	-	-	-	-	8.8	24.3	21.3	--	--	--	--	--
Calhoun	110.6	-	-	-	-	-	-	-	-	-	-	18.9	17.3	72.3	2.1	2.1	--	--	--
Cass	76.9	0.2	0.2	-	-	-	-	-	-	-	-	17.6	14.8	44.3	--	--	--	--	--
Clinton	53.8	-	-	-	-	-	-	-	-	-	-	13.1	21.3	19.4	--	--	--	--	--
Eaton	82.1	-	-	-	-	-	-	-	-	-	-	3.7	46.2	32.2	--	--	--	--	--
Genesee	64.9	1.6	1.6	-	-	-	-	-	-	-	-	15.2	18.9	27.5	1.7	--	1.7	--	--
Gratiot	49.2	2.1	-	-	2.1	-	-	-	-	-	-	19.2	1.5	26.4	--	--	--	--	--
Hillsdale	74.1	8.9	4.2	-	4.7	0.7	-	-	-	-	0.7	11.8	16.7	36.0	--	--	--	--	--
Huron	64.5	-	-	-	-	-	-	-	-	-	-	2.9	25.1	25.1	11.4	8.5	--	2.9	--
Ingham	62.0	-	-	-	-	-	-	-	-	-	-	3.6	11.0	47.4	--	--	--	--	--
Ionia	74.6	-	-	-	-	3.8	-	3.8	-	-	-	11.6	3.9	34.6	20.7	20.7	--	--	--
Jackson	82.3	2.7	2.7	-	-	-	-	-	-	-	-	36.4	10.9	32.3	--	-	--	--	--
Kalamazoo	75.0	12.8	7.1	5.7	-	-	-	-	-	-	-	16.0	13.8	29.2	3.2	3.2	--	--	--
Kent	155.5	15.6	2.4	13.2	-	-	-	-	-	-	-	45.2	29.4	56.3	9.0	9.0	--	--	--
Lapeer	109.4	6.7	-	6.7	-	6.7	-	3.7	-	-	3.0	21.3	33.3	38.4	3.0	3.0	--	--	--
Lenawee	55.2	-	-	-	-	-	-	-	-	-	-	11.3	13.0	28.7	2.2	2.2	--	--	--
Livingston	94.1	2.6	-	2.6	-	-	-	-	-	-	-	39.9	22.7	28.9	--	--	--	--	--
Macomb	60.6	-	-	-	-	-	-	-	-	-	-	12.9	25.6	22.1	--	--	--	--	--
Monroe	37.9	-	-	-	-	-	-	-	-	-	-	10.5	3.4	24.0	--	--	--	--	--
Montcalm	133.0	7.0	-	4.3	2.7	4.1	-	-	-	-	4.1	29.9	39.1	42.9	10.0	10.0	--	--	--
Muskegon	159.9	19.6	7.1	11.6	0.9	-	-	-	-	-	-	71.2	15.5	40.5	6.5	6.5	--	--	6.6
Oakland	111.2	-	-	-	-	-	-	-	-	-	-	24.6	23.6	60.4	2.6	2.6	--	--	--
Ottawa	79.1	9.6	4.9	4.7	-	-	-	-	-	-	-	15.2	18.1	32.8	3.4	3.4	--	--	--
Saginaw	98.9	6.4	1.1	-	5.3	-	-	-	-	-	-	28.1	22.2	38.5	3.7	3.7	--	--	--
St. Clair	78.3	-	-	-	-	-	-	-	-	-	-	14.4	11.0	48.3	4.6	4.6	--	--	--
St. Joseph	65.6	2.8	-	-	2.8	-	-	-	-	-	-	25.0	14.5	21.0	2.3	2.3	--	--	--
Sanilac	79.9	2.6	-	-	2.6	-	-	-	-	-	-	--	13.2	45.1	19.0	10.8	5.3	2.9	--
Shiawassee	50.2	-	-	-	-	-	-	-	-	-	-	16.6	17.2	16.4	--	--	--	--	--
Tuscola	115.5	-	-	-	-	6.0	-	-	-	-	-	3.1	39.1	43.3	24.0	24.0	--	--	--
Van Buren	122.3	1.1	1.1	-	-	-	-	-	-	-	-	19.0	22.1	77.7	2.4	2.4	--	--	--
Washtenaw	82.2	-	-	-	-	-	-	-	-	-	-	37.2	12.5	31.4	1.1	--	--	1.1	--
Wayne	30.9	-	-	-	-	-	-	-	-	-	-	9.4	14.3	7.2	--	--	--	--	--
Total	3,000.7	116.2	43.2	49.4	23.6	22.4	-	8.6	-	6.0	7.8	746.4	671.3	1,300.9	136.9	123.0	7.0	6.9	6.6
All counties	18,615.9	1,977.1	846.1	897.2	233.8	2,673.4	563.1	146.9	465.1	1,349.4	148.9	1,981.8	1,626.9	7,161.3	3,156.9	2,675.7	291.5	189.7	38.5

Table 4. -- Area of timberland by Forest Survey Unit, county, and stand-size class, Michigan, 1993

(In thousand acres)

Forest Survey Unit and county	All stands	Stand-size class			
		Sawtimber	Poletimber	Sapling-seedling	Nonstocked
Eastern Upper Peninsula					
Alger	471.4	260.6	116.4	92.3	2.1
Chippewa	707.7	288.5	184.3	234.9	-
Delta	595.5	197.6	204.0	193.9	-
Luce	463.4	265.8	101.1	93.8	2.7
Mackinac	522.2	189.6	186.6	143.6	2.4
Menominee	523.3	120.3	201.5	200.4	1.1
Schoolcraft	525.4	231.0	136.1	158.3	-
Total	3,808.9	1,553.4	1,130.0	1,117.2	8.3
Western Upper Peninsula					
Baraga	486.7	310.5	80.6	95.6	-
Dickinson	398.2	151.2	155.4	91.6	-
Gogebic	608.4	299.1	223.2	84.4	1.7
Houghton	528.9	292.7	154.7	81.5	-
Iron	658.0	291.0	180.8	186.2	-
Keweenaw	198.5	124.6	43.2	30.7	-
Marquette	1,005.1	458.6	264.6	276.9	5.0
Ontonagon	705.6	346.9	191.0	167.7	-
Total	4,589.4	2,274.6	1,293.5	1,014.6	6.7
Northern Lower Peninsula					
Alcona	321.9	173.5	113.3	34.7	0.4
Alpena	233.0	77.5	91.7	62.1	1.7
Antrim	189.7	74.9	79.8	35.0	-
Arenac	121.1	39.9	29.9	51.3	-
Bay	43.3	12.6	11.1	19.6	-
Benzie	136.9	67.4	38.5	31.0	-
Charlevoix	170.4	106.7	57.5	6.2	-
Cheboygan	339.6	128.1	109.7	101.8	-
Clare	245.5	116.7	64.1	64.7	-
Crawford	290.0	102.6	113.7	73.7	-
Emmet	197.6	83.7	83.9	30.0	-
Gladwin	186.9	66.7	60.7	59.5	-
Grand Traverse	170.9	81.8	68.7	20.4	-
Iosco	242.6	110.4	85.6	46.6	-
Isabella	101.6	48.5	26.4	26.7	-
Kalkaska	267.4	99.7	106.2	59.0	2.5
Lake	315.2	151.1	95.5	68.6	-
Leelanau	88.4	56.3	22.3	9.8	-
Manistee	249.1	100.6	89.8	58.7	-
Mason	157.0	88.9	42.9	25.2	-
Mecosta	163.4	59.9	51.7	51.8	-
Midland	175.6	82.2	39.7	53.7	-
Missaukee	229.3	86.4	75.5	67.4	-
Montmorency	293.6	107.2	85.9	96.6	3.9
Newaygo	330.4	202.3	93.2	34.9	-
Oceana	182.0	91.3	40.9	49.0	0.8
Ogemaw	228.5	73.1	95.7	59.7	-
Osceola	185.6	65.0	57.6	60.8	2.2
Oscoda	307.9	105.3	79.7	120.8	2.1
Otsego	239.6	86.8	109.1	41.6	2.1
Presque Isle	298.8	98.9	122.6	76.1	1.2
Roscommon	254.8	120.1	72.3	62.4	-
Wexford	259.3	86.7	139.5	33.1	-
Total	7,216.9	3,052.8	2,454.7	1,692.5	16.9

(Table 4 continued on next page)

(Table 4 continued)

Forest Survey Unit and county	All stands	Stand-size class			
		Sawtimber	Poletimber	Sapling-seedling	Nonstocked
Southern Lower Peninsula					
Allegan	178.4	111.7	35.4	31.3	-
Barry	111.2	67.3	15.4	28.5	-
Berrien	67.0	61.2	4.0	1.8	-
Branch	54.4	30.4	11.5	12.5	-
Calhoun	110.6	67.8	30.8	12.0	-
Cass	76.9	50.7	22.2	4.0	-
Clinton	53.8	22.8	10.4	20.6	-
Eaton	82.1	48.5	33.6	-	-
Genesee	64.9	27.2	8.1	29.6	-
Gratiot	49.2	29.3	5.5	14.4	-
Hillsdale	74.1	39.3	21.8	13.0	-
Huron	64.5	37.4	15.3	11.8	-
Ingham	62.0	43.1	7.9	11.0	-
Ionia	74.6	38.4	36.2	-	-
Jackson	82.3	66.0	8.0	8.3	-
Kalamazoo	75.0	42.7	18.3	14.0	-
Kent	155.5	83.7	34.7	37.1	-
Lapeer	109.4	51.6	21.9	35.9	-
Lenawee	55.2	33.2	13.3	8.7	-
Livingston	94.1	84.3	4.6	5.2	-
Macomb	60.6	19.1	19.1	22.4	-
Monroe	37.9	27.2	9.7	1.0	-
Montcalm	133.0	83.2	32.3	17.5	-
Muskegon	159.9	86.0	39.6	27.7	6.6
Oakland	111.2	52.8	27.3	31.1	-
Ottawa	79.1	50.7	19.0	9.4	-
Saginaw	98.9	31.8	38.1	29.0	-
St. Clair	78.3	46.4	15.2	16.7	-
St. Joseph	65.6	48.2	9.2	8.2	-
Sanilac	79.9	19.1	19.9	40.9	-
Shiawassee	50.2	36.2	5.4	8.6	-
Tuscola	115.5	34.0	36.4	45.1	-
Van Buren	122.3	73.9	18.4	30.0	-
Washtenaw	82.2	60.0	6.7	15.5	-
Wayne	30.9	18.9	7.9	4.1	-
Total	3,000.7	1,724.1	663.1	606.9	6.6
All counties	18,615.9	8,604.9	5,541.3	4,431.2	38.5

Table 5. -- Area of timberland by Forest Survey Unit, county, and potential productivity class, Michigan, 1993

(In thousand acres)

Forest Survey Unit and county	All classes	Potential productivity class (cubic feet of growth per acre per year) 165+	120-164	85-119	50-84	20- 49
Eastern Upper Peninsula						
Alger	471.4	-	13.5	72.5	208.0	177.4
Chippewa	707.7	-	12.1	95.9	225.9	373.8
Delta	595.5	-	19.4	96.4	237.9	241.8
Luce	463.4	-	3.9	38.8	161.0	259.7
Mackinac	522.2	1.8	13.1	81.6	203.7	222.0
Menominee	523.3	2.4	31.0	86.9	196.5	206.5
Schoolcraft	525.4	-	15.9	44.2	199.6	265.7
Total	3,808.9	4.2	108.9	516.3	1,432.6	1,746.9
Western Upper Peninsula						
Baraga	486.7	1.2	8.8	65.9	215.6	195.2
Dickinson	398.2	2.2	17.8	95.0	180.2	103.0
Gogebic	608.4	1.2	43.8	103.6	262.4	197.4
Houghton	528.9	-	23.3	105.4	295.3	104.9
Iron	658.0	1.1	38.3	130.8	330.7	157.1
Keweenaw	198.5	-	1.2	12.9	53.4	131.0
Marquette	1,005.1	1.3	29.9	122.7	402.9	448.3
Ontonagon	705.6	1.8	23.7	159.1	367.9	153.1
Total	4,589.4	8.8	186.8	795.4	2,108.4	1,490.0
Northern Lower Peninsula						
Alcona	321.9	4.3	26.3	92.6	137.2	61.5
Alpena	233.0	2.3	10.0	63.9	70.4	86.4
Antrim	189.7	2.1	4.2	56.6	80.1	46.7
Arenac	121.1	1.8	5.0	44.1	48.7	21.5
Bay	43.3	2.7	-	20.8	14.2	5.6
Benzie	136.9	3.3	15.1	23.8	51.8	42.9
Charlevoix	170.4	-	3.9	49.8	77.4	39.3
Cheboygan	339.6	-	9.1	78.5	144.4	107.6
Clare	245.5	2.1	16.4	81.2	86.9	58.9
Crawford	290.0	-	4.3	29.7	106.9	149.1
Emmet	197.6	2.3	5.0	49.4	97.8	43.1
Gladwin	186.9	1.8	17.2	58.7	91.5	17.7
Grand Traverse	170.9	-	2.7	30.1	69.3	68.8
Iosco	242.6	-	4.7	57.0	77.9	103.0
Isabella	101.6	-	17.0	44.5	29.9	10.2
Kalkaska	267.4	-	7.9	70.0	99.6	89.9
Lake	315.2	-	25.2	75.4	114.7	99.9
Leelanau	88.4	1.1	9.6	12.4	36.5	28.8
Manistee	249.1	-	6.9	59.8	119.5	62.9
Mason	157.0	-	14.3	35.9	72.2	34.6
Mecosta	163.4	1.9	11.9	56.4	72.9	20.3
Midland	175.6	-	4.1	49.5	93.4	28.6
Missaukee	229.3	-	22.5	68.3	77.3	61.2
Montmorency	293.6	-	5.2	55.6	154.2	78.6
Newaygo	330.4	0.9	18.2	82.0	162.8	66.5
Oceana	182.0	-	12.7	40.5	88.7	40.1
Ogemaw	228.5	1.8	8.4	59.4	76.0	82.9
Osceola	185.6	-	19.3	68.5	75.2	22.6
Oscoda	307.9	-	11.1	50.9	130.7	115.2
Otsego	239.6	4.4	4.1	60.0	125.1	46.0
Presque Isle	298.8	-	2.2	29.2	107.7	159.7
Roscommon	254.8	1.7	3.5	53.8	107.9	87.9
Wexford	259.3	0.5	11.8	82.6	99.3	65.1
Total	7,216.9	35.0	339.8	1,790.9	2,998.1	2,053.1

(Table 5 continued on next page)

(Table 5 continued)

Forest Survey Unit and county	All classes	Potential productivity class (cubic feet of growth per acre per year) 165+	120-164	85-119	50-84	20-49
Southern Lower Peninsula						
Allegan	178.4	7.9	5.9	59.2	86.1	19.3
Barry	111.2	7.8	8.3	50.7	34.1	10.3
Berrien	67.0	6.9	6.7	38.4	15.0	-
Branch	54.4	-	6.1	29.3	19.0	-
Calhoun	110.6	3.8	7.5	60.7	38.6	-
Cass	76.9	4.3	9.1	37.7	20.8	5.0
Clinton	53.8	-	-	25.7	17.1	11.0
Eaton	82.1	3.6	11.0	42.7	24.8	-
Genesee	64.9	-	3.7	37.7	18.5	5.0
Gratiot	49.2	-	-	29.4	15.9	3.9
Hillsdale	74.1	-	12.9	31.4	24.4	5.4
Huron	64.5	-	8.6	17.3	27.0	11.6
Ingham	62.0	3.6	7.2	40.2	9.3	1.7
Ionia	74.6	3.8	15.5	19.1	36.2	-
Jackson	82.3	5.4	8.0	35.2	23.9	9.8
Kalamazoo	75.0	5.9	9.6	25.9	23.8	9.8
Kent	155.5	5.1	14.0	53.1	61.8	21.5
Lapeer	109.4	-	9.7	47.7	37.7	14.3
Lenawee	55.2	4.4	2.2	24.6	24.0	-
Livingston	94.1	-	-	54.8	36.3	3.0
Macomb	60.6	-	3.9	22.9	30.0	3.8
Monroe	37.9	-	-	32.5	3.9	1.5
Montcalm	133.0	-	9.4	48.1	49.7	25.8
Muskegon	159.9	-	3.4	42.1	70.7	43.7
Oakland	111.2	-	5.6	39.9	43.4	22.3
Ottawa	79.1	-	8.0	19.5	42.4	9.2
Saginaw	98.9	-	-	23.8	71.8	3.3
St. Clair	78.3	-	4.8	47.8	25.7	-
St. Joseph	65.6	9.2	4.7	27.9	17.4	6.4
Sanilac	79.9	-	-	40.4	39.5	-
Shiawassee	50.2	-	2.8	33.7	13.7	-
Tuscola	115.5	2.6	-	43.1	63.7	6.1
Van Buren	122.3	-	11.2	44.8	61.7	4.6
Washtenaw	82.2	-	-	38.2	39.6	4.4
Wayne	30.9	-	2.3	19.6	3.5	5.5
Total	3,000.7	74.3	202.1	1,285.1	1,171.0	268.2
All counties	18,615.9	122.3	837.6	4,387.7	7,710.1	5,558.2

Table 6. -- Area of timberland by Forest Survey Unit, county, and stocking class of growing-stock trees[1], Michigan, 1993

(In thousand acres)

Forest Survey Unit and county	All classes	Stocking class of growing-stock trees				
		Nonstocked[2]	Poorly stocked	Moderately stocked	Fully stocked	Over-stocked
Eastern Upper Peninsula						
Alger	471.4	3.3	4.1	61.9	220.4	181.7
Chippewa	707.7	-	27.0	120.4	270.1	290.2
Delta	595.5	-	27.3	102.7	216.8	248.7
Luce	463.4	2.7	23.1	123.2	226.6	87.8
Mackinac	522.2	3.5	16.5	69.6	203.3	229.3
Menominee	523.3	3.8	14.0	91.3	234.2	180.0
Schoolcraft	525.4	1.2	23.7	93.8	206.7	200.0
Total	3,808.9	14.5	135.7	662.9	1,578.1	1,417.7
Western Upper Peninsula						
Baraga	486.7	-	12.6	50.3	215.4	208.4
Dickinson	398.2	-	11.7	78.9	192.5	115.1
Gogebic	608.4	1.7	17.1	163.1	272.5	154.0
Houghton	528.9	12.1	29.8	112.1	231.1	143.8
Iron	658.0	1.8	25.9	104.2	311.5	214.6
Keweenaw	198.5	-	5.4	29.8	94.0	69.3
Marquette	1,005.1	6.4	30.5	104.0	408.9	455.3
Ontonagon	705.6	-	18.4	98.0	250.6	338.6
Total	4,589.4	22.0	151.4	740.4	1,976.5	1,699.1
Northern Lower Peninsula						
Alcona	321.9	0.4	13.1	72.2	164.3	71.9
Alpena	233.0	4.0	7.3	46.1	121.4	54.2
Antrim	189.7	-	13.9	33.8	91.1	50.9
Arenac	121.1	-	6.7	39.0	51.0	24.4
Bay	43.3	-	-	15.2	18.2	9.9
Benzie	136.9	-	22.2	24.4	46.9	43.4
Charlevoix	170.4	2.1	8.3	10.2	80.9	68.9
Cheboygan	339.6	6.0	19.5	92.0	158.8	63.3
Clare	245.5	-	20.4	61.0	128.0	36.1
Crawford	290.0	4.0	15.0	102.9	122.1	46.0
Emmet	197.6	2.0	3.4	33.6	98.0	60.6
Gladwin	186.9	-	21.0	60.0	92.1	13.8
Grand Traverse	170.9	1.4	12.4	40.7	76.8	39.6
Iosco	242.6	2.5	24.8	54.9	105.6	54.8
Isabella	101.6	-	9.6	29.3	44.4	18.3
Kalkaska	267.4	3.6	32.6	57.6	116.9	56.7
Lake	315.2	-	7.6	58.7	170.7	78.2
Leelanau	88.4	-	6.0	9.9	41.9	30.6
Manistee	249.1	3.4	23.4	47.1	109.1	66.1
Mason	157.0	-	13.4	30.4	68.5	44.7
Mecosta	163.4	0.5	14.5	41.6	83.6	23.2
Midland	175.6	-	7.3	32.3	113.4	22.6
Missaukee	229.3	-	6.2	57.8	109.6	55.7
Montmorency	293.6	3.9	24.2	75.1	128.2	62.2
Newaygo	330.4	-	17.2	62.4	158.3	92.5
Oceana	182.0	2.3	23.5	30.1	88.1	38.0
Ogemaw	228.5	-	27.5	48.4	102.0	50.6
Osceola	185.6	7.1	29.1	29.9	80.6	38.9
Oscoda	307.9	2.1	25.9	70.8	164.6	44.5
Otsego	239.6	2.1	12.0	60.2	108.3	57.0
Presque Isle	298.8	1.2	14.2	56.2	154.4	72.8
Roscommon	254.8	-	5.3	41.3	138.8	69.4
Wexford	259.3	2.9	10.4	53.8	126.4	65.8
Total	7,216.9	51.5	497.9	1,578.9	3,463.0	1,625.6

(Table 6 continued on next page)

(Table 6 continued)

Forest Survey Unit and county	All classes	Stocking class of growing-stock trees				
		Nonstocked[2]	Poorly stocked	Moderately stocked	Fully stocked	Over-stocked
Southern Lower Peninsula						
Allegan	178.4	-	18.6	33.0	87.2	39.6
Barry	111.2	-	9.8	27.8	52.2	21.4
Berrien	67.0	-	-	14.1	32.5	20.4
Branch	54.4	-	1.9	16.1	30.3	6.1
Calhoun	110.6	-	10.8	32.0	52.7	15.1
Cass	76.9	-	4.3	28.7	31.0	12.9
Clinton	53.8	-	11.8	24.0	18.0	-
Eaton	82.1	-	35.3	13.7	22.0	11.1
Genesee	64.9	-	18.0	19.6	14.9	12.4
Gratiot	49.2	-	6.5	14.8	27.9	-
Hillsdale	74.1	4.4	12.1	24.5	24.6	8.5
Huron	64.5	-	11.5	16.3	28.2	8.5
Ingham	62.0	-	6.8	22.7	32.5	-
Ionia	74.6	-	4.0	15.2	51.5	3.9
Jackson	82.3	-	10.7	28.7	34.8	8.1
Kalamazoo	75.0	1.3	3.1	11.8	41.3	17.5
Kent	155.5	1.1	17.2	48.4	63.7	25.1
Lapeer	109.4	-	21.9	62.5	15.1	9.9
Lenawee	55.2	4.4	2.2	8.8	32.8	7.0
Livingston	94.1	-	14.0	25.2	40.9	14.0
Macomb	60.6	25.7	1.4	11.3	15.9	6.3
Monroe	37.9	-	1.5	12.5	16.4	7.5
Montcalm	133.0	-	13.1	46.6	49.4	23.9
Muskegon	159.9	6.6	5.6	22.2	97.5	28.0
Oakland	111.2	2.6	21.4	42.9	35.6	8.7
Ottawa	79.1	7.7	7.0	23.4	32.6	8.4
Saginaw	98.9	-	5.2	26.7	52.2	14.8
St. Clair	78.3	-	1.9	19.8	39.4	17.2
St. Joseph	65.6	2.7	5.4	23.6	21.5	12.4
Sanilac	79.9	-	24.4	33.5	16.2	5.8
Shiawassee	50.2	3.0	-	11.0	21.7	14.5
Tuscola	115.5	-	24.0	29.2	53.7	8.6
Van Buren	122.3	2.5	15.6	34.0	50.4	19.8
Washtenaw	82.2	5.2	12.3	24.1	30.1	10.5
Wayne	30.9	-	4.1	10.3	11.8	4.7
Total	3,000.7	67.2	363.4	859.0	1,278.5	432.6
All counties	18,615.9	155.2	1,148.4	3,841.2	8,296.1	5,175.0

[1] This table is based on the stocking percent of growing-stock trees, rather than that of all live trees. For this table, to use the definition of stocking found in the Appendix, replace the term "all live" by "growing-stock."

[2] Area of nonstocked in this table and in Table 8 differs from that in other tables in this report because this table includes land stocked only with growing-stock trees, rather than with all live trees.

Table 7. -- Area of timberland by forest type group/local type and ownership class, Michigan, 1993

(In thousand acres)

Forest type group/ local type	All ownerships	Ownership class									
		Public					Private				
		Total public	National forest	Other federal	State	County & municipal	Total private	Indian	Forest industry	Individual	Corporate
White-red-jack pine											
Jack pine	846.1	575.0	208.3	15.3	333.3	18.1	271.1	-	7.4	210.2	53.5
Red pine	897.2	585.8	322.8	3.7	239.6	19.7	311.4	-	22.4	233.4	55.6
White pine	233.8	105.7	41.8	1.3	62.6	-	128.1	-	4.7	87.8	35.6
Total	1,977.1	1,266.5	572.9	20.3	635.5	37.8	710.6	-	34.5	531.4	144.7
Spruce-fir											
Balsam fir	563.1	215.5	91.3	5.2	112.5	6.5	347.6	-	91.2	180.1	76.3
White spruce	146.9	65.0	39.5	-	25.5	-	81.9	-	9.9	51.6	20.4
Black spruce	465.1	236.0	89.6	-	143.0	3.4	229.1	-	66.6	118.8	43.7
Northern white-cedar	1,349.4	524.5	145.0	-	362.9	16.6	824.9	1.6	195.8	504.3	123.2
Tamarack	148.9	65.8	19.5	-	41.1	5.2	83.1	-	13.3	51.6	18.2
Total	2,673.4	1,106.8	384.9	5.2	685.0	31.7	1,566.6	1.6	376.8	906.4	281.8
Oak-hickory											
Oak-hickory	1,981.8	726.2	271.5	-	422.0	32.7	1,255.6	-	9.8	1,077.1	168.7
Total	1,981.8	726.2	271.5	-	422.0	32.7	1,255.6	-	9.8	1,077.1	168.7
Elm-ash-cottonwood											
Elm-ash-soft maple	1,626.9	356.3	108.5	-	226.4	21.4	1,270.6	1.8	54.9	1,037.7	176.2
Total	1,626.9	356.3	108.5	-	226.4	21.4	1,270.6	1.8	54.9	1,037.7	176.2
Maple-beech-birch											
Maple-beech-birch	7,161.3	1,925.3	835.3	12.0	969.3	108.7	5,236.0	9.0	868.4	3,424.3	934.3
Total	7,161.3	1,925.3	835.3	12.0	969.3	108.7	5,236.0	9.0	868.4	3,424.3	934.3
Aspen-birch											
Aspen	2,675.7	1,034.7	329.2	11.1	671.2	23.2	1,641.0	1.3	127.2	1,221.3	291.2
Paper birch	291.5	95.2	19.2	1.0	75.0	-	196.3	0.9	24.8	120.8	49.8
Balsam poplar	189.7	48.8	20.9	-	27.9	-	140.9	-	17.9	110.8	12.2
Total	3,156.9	1,178.7	369.3	12.1	774.1	23.2	1,978.2	2.2	169.9	1,452.9	353.2
Nonstocked	38.5	16.7	-	-	15.9	0.8	21.8	-	-	18.7	3.1
All Types	18,615.9	6,576.5	2,542.4	49.6	3,728.2	256.3	12,039.4	14.6	1,514.3	8,448.5	2,062.0

Table 8. -- Area of timberland by ownership class and stocking class of growing-stock trees[1], Michigan, 1993

(In thousand acres)

Ownership class	All classes	Stocking class of growing-stock trees				
		Nonstocked [2]	Poorly stocked	Moderately stocked	Fully stocked	Over-stocked
Public						
National forest	2,542.4	2.9	87.9	420.6	970.0	1,061.0
Other federal	49.6	-	2.4	10.1	25.8	11.3
State	3,728.2	28.0	210.8	791.3	1,644.2	1,053.9
County and municipal	256.3	0.8	13.2	62.1	112.7	67.5
Total	6,576.5	31.7	314.3	1,284.1	2,752.7	2,193.7
Private						
Indian	14.6	-	-	1.8	1.3	11.5
Forest industry	1,514.3	-	33.7	252.4	723.3	504.9
Individual	8,448.5	85.6	669.5	1,916.8	3,907.2	1,869.4
Corporate	2,062.0	37.9	130.9	386.1	911.6	595.5
Total	12,039.4	123.5	834.1	2,557.1	5,543.4	2,981.3
All ownerships	18,615.9	155.2	1,148.4	3,841.2	8,296.1	5,175.0

[1] This table is based on the stocking percent of growing-stock trees, rather than that of all live trees. For this table, to use the definition of stocking found in the Appendix, replace the term "all live" by "growing-stock."

[2] Area of nonstocked in this table and in table 6 differs from that in other tables in this report because this table includes land stocked only with growing-stock trees, rather than with all live trees.

Table 9. -- Area of timberland by forest type group/local type and stand-size class, Michigan, 1993

(In thousand acres)

Forest type group/ local type	All stands	Stand-size class			
		Sawtimber	Poletimber	Sapling-seedling	Nonstocked
White-red-jack pine					
Jack pine	846.1	258.0	349.6	238.5	-
Red pine	897.2	430.7	344.0	122.5	-
White pine	233.8	173.8	30.5	29.5	-
Total	1,977.1	862.5	724.1	390.5	-
Spruce-fir					
Balsam fir	563.1	177.3	158.2	227.6	-
White spruce	146.9	47.1	48.9	50.9	-
Black spruce	465.1	49.5	141.1	274.5	-
Northern white-cedar	1,349.4	594.8	582.2	172.4	-
Tamarack	148.9	31.5	40.2	77.2	-
Total	2,673.4	900.2	970.6	802.6	-
Oak-hickory					
Oak-hickory	1,981.8	1,230.0	457.1	294.7	-
Total	1,981.8	1,230.0	457.1	294.7	-
Elm-ash-cottonwood					
Elm-ash-soft maple	1,626.9	756.5	469.8	400.6	-
Total	1,626.9	756.5	469.8	400.6	-
Maple-beech-birch					
Maple-beech-birch	7,161.3	3,848.4	1,979.2	1,333.7	-
Total	7,161.3	3,848.4	1,979.2	1,333.7	-
Aspen-birch					
Aspen	2,675.7	850.7	720.6	1,104.4	-
Paper birch	291.5	90.4	166.8	34.3	-
Balsam poplar	189.7	66.2	53.1	70.4	-
Total	3,156.9	1,007.3	940.5	1,209.1	-
Nonstocked	38.5	-	-	-	38.5
All types	18,615.9	8,604.9	5,541.3	4,431.2	38.5

Table 10. -- Number of all live trees on timberland by species group and diameter class, Michigan, 1993
(In thousand trees)

Species group	All classes	Diameter class (inches at breast height)											
		1.0-2.9	3.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods		Number of live trees											
Jack pine	288,542	104,086	65,381	54,568	37,888	17,579	6,768	1,642	497	116	12	5	-
Red pine	348,613	43,930	70,267	98,771	77,758	32,564	13,815	6,007	2,717	1,513	742	528	1
White pine	188,278	83,758	39,930	24,366	12,617	9,427	6,119	3,806	2,607	1,965	1,320	2,138	225
White spruce	145,074	57,722	36,508	19,160	13,375	7,836	5,160	2,726	1,401	767	254	160	5
Black spruce	331,309	146,517	103,059	55,028	19,625	5,138	1,432	304	112	73	17	4	-
Balsam fir	1,100,257	654,086	270,746	105,912	44,905	18,066	4,640	1,472	319	87	13	11	-
Hemlock	111,348	31,035	21,252	15,539	10,320	9,856	7,677	5,748	4,402	2,474	1,366	1,593	86
Tamarack	110,457	47,842	30,674	17,872	8,203	3,508	1,500	522	226	77	21	8	4
Eastern redcedar	2,917	1,728	483	465	144	70	19	6	-	-	-	2	-
Northern white-cedar	1,015,683	327,251	282,615	204,787	110,738	51,529	22,126	9,963	3,829	1,730	666	438	11
Other softwoods	60,929	14,258	19,442	14,080	8,387	3,522	966	174	87	-	13	-	-
Total softwoods	3,703,407	1,512,213	940,357	610,548	343,960	159,095	70,222	32,370	16,197	8,802	4,424	4,887	332
Hardwoods													
Select white oak	172,982	65,379	33,501	25,175	15,481	12,271	7,227	5,278	3,331	2,184	1,212	1,634	309
Other white oak	458	261	45	29	33	90	-	-	-	-	-	-	-
Select red oak	260,453	105,490	33,085	30,307	23,981	22,511	17,409	11,719	6,434	3,935	2,543	2,794	245
Other red oak	79,867	30,280	11,984	11,730	7,588	6,279	4,415	2,805	2,180	1,199	713	609	85
Select hickory	19,956	9,676	2,946	1,926	1,382	1,493	1,069	760	379	171	85	68	1
Other hickory	18,187	8,713	3,394	2,090	1,277	1,005	856	438	201	134	53	26	-
Basswood	147,903	45,971	22,043	19,615	20,573	16,392	11,953	5,863	2,958	1,361	603	547	24
Beech	137,560	74,176	21,910	13,818	8,185	6,050	3,986	3,134	2,553	1,587	891	1,191	79
Yellow birch	160,266	58,027	37,954	24,251	14,220	9,734	5,939	3,868	2,766	1,566	800	1,050	91
Hard maple	1,526,564	720,643	315,478	219,318	118,321	70,387	37,916	19,505	11,602	6,626	3,262	3,249	257
Soft maple	1,427,221	678,184	313,495	185,195	110,295	66,030	34,961	18,116	10,000	5,302	2,528	2,763	352
Elm	260,689	145,211	66,421	24,813	12,253	6,640	2,908	1,281	659	281	89	131	2
Black ash	365,994	203,899	94,423	39,829	16,554	6,258	2,790	1,432	497	199	63	50	-
White & green ash	327,105	176,841	63,024	34,505	21,959	12,484	7,738	4,693	2,928	1,570	649	648	66
Sycamore	999	288	-	156	24	149	116	61	20	64	12	86	23
Cottonwood	11,766	2,617	1,997	1,991	1,201	848	803	691	609	382	191	328	108
Willow	9,161	3,462	1,535	1,282	761	540	468	283	347	141	113	177	52
Hackberry	2,609	1,018	844	535	112	49	12	11	9	19	-	-	-
Balsam poplar	113,501	59,582	19,869	12,252	7,382	6,212	3,347	2,185	1,310	656	339	357	10
Bigtooth aspen	394,892	204,333	73,095	37,018	26,615	22,431	16,087	9,227	3,690	1,460	577	353	6
Quaking aspen	1,062,811	625,602	193,935	94,609	55,930	40,869	26,260	13,510	7,083	3,245	1,028	734	6
Paper birch	263,755	77,349	59,989	54,850	35,471	21,157	9,386	3,547	1,286	462	139	113	6
Tupelo	3,920	1,557	826	962	293	159	29	69	-	-	-	25	-
Black cherry	297,353	187,473	41,336	26,918	18,025	11,441	5,881	3,405	1,494	819	286	266	9
Black walnut	8,375	2,274	1,263	1,615	1,049	901	526	348	161	122	55	53	8
Butternut	2,507	639	1,059	161	240	115	158	69	29	19	6	12	-
Yellow-poplar	3,188	903	501	499	167	259	267	158	165	60	116	87	6
Sassafras	70,096	42,742	14,411	6,811	3,472	1,402	779	334	97	44	-	4	-
Other hardwoods	59,525	42,620	7,449	4,840	2,504	1,090	624	195	124	25	42	9	3
Total hardwoods	7,209,663	3,575,210	1,437,812	877,100	525,348	345,246	203,910	112,985	62,912	33,633	16,395	17,364	1,748
Noncommercial species	493,902	376,571	83,486	23,928	6,876	2,228	580	165	24	4	11	25	4
All species	11,406,972	5,463,994	2,461,655	1,511,576	876,184	506,569	274,712	145,520	79,133	42,439	20,830	22,276	2,084

Table 11. -- Number of growing-stock trees on timberland by species group and diameter class, Michigan, 1993

(In thousand trees)

Species group	All classes	Diameter class (inches at breast height)											
		1.0-2.9	3.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods		(Number of growing-stock trees)											
Jack pine	275,352	102,416	61,926	50,769	35,786	16,229	6,230	1,507	380	98	7	4	-
Red pine	341,718	43,345	68,272	97,041	76,183	31,875	13,644	5,936	2,676	1,495	730	520	1
White pine	181,399	83,275	38,508	22,952	11,419	8,434	5,667	3,457	2,413	1,799	1,257	2,012	206
White spruce	143,357	57,515	36,118	18,661	13,138	7,658	5,021	2,685	1,401	752	251	155	2
Black spruce	325,896	144,085	101,469	54,245	19,172	5,015	1,407	299	110	73	17	4	-
Balsam fir	1,091,019	650,895	267,790	104,220	44,181	17,687	4,469	1,366	307	83	10	11	-
Hemlock	101,753	30,670	20,186	13,803	8,821	7,903	6,489	5,020	3,841	2,271	1,240	1,436	73
Tamarack	106,104	46,883	29,612	16,753	7,570	3,167	1,355	480	191	70	19	4	-
Eastern redcedar	2,687	1,530	483	465	144	48	9	6	-	-	-	2	-
Northern white-cedar	933,138	317,490	264,824	183,726	96,437	41,771	16,815	7,383	2,819	1,176	425	266	6
Other softwoods	54,418	13,937	17,084	12,916	6,657	2,804	774	155	79	-	12	-	-
Total softwoods	3,556,841	1,492,041	906,272	575,551	319,508	142,591	61,880	28,294	14,217	7,817	3,968	4,414	288
Hardwoods													
Select white oak	164,779	64,450	31,037	24,040	14,621	11,425	6,724	4,812	3,069	1,964	1,046	1,391	200
Other white oak	413	261	45	29	33	45	-	-	-	-	-	-	-
Select red oak	249,991	105,367	31,327	28,132	22,762	21,104	15,856	10,898	5,889	3,679	2,351	2,451	175
Other red oak	74,328	30,031	10,535	10,458	6,812	5,745	3,928	2,496	2,017	1,095	625	524	62
Select hickory	19,500	9,490	2,946	1,886	1,340	1,493	1,004	684	365	171	52	68	1
Other hickory	18,034	8,713	3,394	2,090	1,194	998	856	405	201	120	44	19	-
Basswood	140,719	45,614	20,481	18,161	19,462	15,442	11,169	5,410	2,727	1,241	569	430	13
Beech	126,251	71,519	20,280	12,477	6,994	4,908	3,172	2,303	1,838	1,243	634	831	52
Yellow birch	136,774	54,886	33,333	19,388	10,613	7,345	4,327	2,672	2,047	1,031	538	568	26
Hard maple	1,446,448	698,371	298,703	205,172	109,258	63,358	33,083	16,943	10,189	5,721	2,853	2,663	134
Soft maple	1,350,757	667,354	292,078	169,456	100,399	58,851	29,948	15,583	8,439	4,278	2,033	2,127	211
Elm	250,438	143,718	61,936	23,178	10,973	6,176	2,488	1,036	528	233	85	86	1
Black ash	343,723	197,899	86,434	35,248	14,247	5,430	2,417	1,329	449	168	60	42	-
White & green ash	317,394	175,779	59,493	32,644	20,765	11,836	7,053	4,347	2,742	1,492	588	607	48
Sycamore	884	288	-	49	24	149	116	61	20	64	12	82	19
Cottonwood	11,024	2,479	1,715	1,961	1,036	826	777	670	582	379	179	318	102
Willow	7,402	3,360	1,319	807	597	398	251	187	212	75	74	99	23
Hackberry	2,609	1,018	844	535	112	49	12	11	9	19	-	-	-
Balsam poplar	108,983	58,820	18,561	11,427	6,881	5,763	3,079	2,054	1,154	603	305	326	10
Bigtooth aspen	382,689	203,381	70,320	34,036	24,839	21,292	15,166	8,459	3,306	1,187	474	227	2
Quaking aspen	1,021,830	620,845	185,244	86,072	50,487	36,549	22,315	11,188	5,573	2,390	693	469	5
Paper birch	243,958	75,345	55,410	49,451	31,970	19,046	8,069	3,077	1,057	373	106	54	-
Tupelo	3,556	1,503	826	905	166	65	13	61	-	-	-	17	-
Black cherry	265,095	182,412	31,755	20,653	12,819	8,525	4,291	2,482	1,136	588	214	211	9
Black walnut	7,966	2,274	1,197	1,560	965	799	511	307	161	111	47	34	-
Butternut	2,262	639	1,059	72	169	91	133	48	29	15	6	1	-
Yellow-poplar	3,178	903	501	499	167	259	267	158	165	60	109	87	3
Sassafras	63,862	42,457	11,838	5,064	2,555	1,051	536	243	97	17	-	4	-
Other hardwoods	53,670	41,696	5,778	3,437	1,660	649	296	63	73	9	-	9	-
Total hardwoods	6,818,517	3,510,872	1,338,389	798,887	473,920	309,667	177,857	97,987	54,074	28,326	13,697	13,745	1,096
All species	10,375,358	5,002,913	2,244,661	1,374,438	793,428	452,258	239,737	126,281	68,291	36,143	17,665	18,159	1,384

Table 12. -- Net volume of growing stock on timberland by species group and diameter class, Michigan, 1993

(In thousand cubic feet)

Species group	All classes	Diameter class (inches at breast height)									
		5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods											
Jack pine	603,319	116,849	185,862	153,521	94,975	34,556	12,454	4,419	433	250	-
Red pine	1,626,692	268,878	443,603	321,915	219,097	139,941	88,323	64,877	40,782	39,116	160
White pine	869,620	51,571	60,211	83,214	91,785	84,721	86,031	86,905	79,371	202,505	43,306
White spruce	494,221	48,900	81,842	84,450	90,312	71,617	51,598	36,285	15,270	13,671	276
Black spruce	365,055	152,618	116,697	54,794	24,356	7,810	3,831	3,641	1,045	263	-
Balsam fir	822,551	262,681	255,564	182,399	73,654	32,778	10,178	3,817	561	919	-
Hemlock	661,724	22,544	35,780	61,856	83,387	98,592	105,872	83,634	58,078	100,984	10,997
Tamarack	180,922	49,652	48,120	35,539	23,903	12,473	6,574	3,242	1,051	368	-
Eastern redcedar	2,931	1,169	849	465	174	126	-	-	-	148	-
Northern white-cedar	1,832,717	422,903	490,348	373,532	235,104	150,438	79,406	43,307	20,015	16,890	774
Other softwoods	112,318	30,236	35,213	27,909	11,905	3,689	2,703	-	663	-	-
Total softwoods	7,572,070	1,428,001	1,754,089	1,379,594	948,652	636,741	446,970	330,127	217,269	375,114	55,513
Hardwoods											
Select white oak	819,566	56,480	77,453	107,013	100,476	104,513	93,039	80,440	54,838	110,875	34,439
Other white oak	644	71	178	395	-	-	-	-	-	-	-
Select red oak	1,604,647	65,993	125,538	206,719	244,869	249,638	188,025	157,438	129,257	205,221	31,949
Other red oak	397,604	23,102	34,271	53,090	55,665	53,004	58,729	41,633	31,245	37,947	8,918
Select hickory	92,659	4,573	7,757	15,299	16,727	17,569	13,064	8,319	3,010	6,099	242
Other hickory	65,120	4,480	6,848	10,326	15,229	10,267	7,392	6,239	2,594	1,745	-
Basswood	903,635	53,149	124,197	174,075	195,764	137,405	93,861	55,087	32,312	34,517	3,268
Beech	477,377	36,042	44,891	57,584	56,416	57,569	63,019	54,240	35,037	65,476	7,103
Yellow birch	498,381	51,638	63,962	76,916	68,621	61,186	63,584	41,261	26,962	40,917	3,334
Hard maple	4,042,740	573,338	705,537	725,899	586,350	435,230	355,409	261,128	162,239	216,336	21,274
Soft maple	3,452,234	456,263	627,829	651,145	518,065	387,439	287,439	190,197	114,591	176,269	42,997
Elm	282,103	55,234	60,334	64,297	40,217	24,231	16,754	9,750	4,422	6,720	144
Black ash	338,088	91,895	84,438	58,134	41,447	32,943	14,830	7,458	3,442	3,501	-
White & green ash	814,075	82,498	120,778	124,110	119,722	108,215	93,794	69,010	34,626	52,623	8,699
Sycamore	23,004	207	149	1,678	2,191	1,822	712	3,428	754	8,068	3,995
Cottonwood	131,894	3,359	5,347	8,347	12,206	14,873	18,840	15,837	9,403	27,193	16,489
Willow	43,316	1,827	3,068	3,697	3,708	4,266	6,364	3,074	3,999	9,044	4,269
Hackberry	4,628	1,647	788	492	177	342	354	828	-	-	-
Balsam poplar	345,096	30,364	40,832	62,572	51,006	49,753	39,081	26,483	17,853	25,453	1,699
Bigtooth aspen	1,236,719	99,530	166,227	246,442	274,687	224,219	121,325	57,008	28,776	18,221	284
Quaking aspen	1,971,082	226,512	304,934	397,251	384,181	279,625	192,562	108,504	38,786	37,879	848
Paper birch	844,859	144,501	206,112	213,194	140,379	76,899	36,554	17,031	6,040	4,149	-
Tupelo	6,192	2,316	895	580	209	1,236	-	-	-	956	-
Black cherry	496,151	61,773	88,249	102,316	79,467	66,551	40,602	27,480	12,636	15,948	1,129
Black walnut	54,445	4,363	6,747	9,056	9,520	8,433	5,680	4,969	2,868	2,809	-
Butternut	8,718	289	1,232	1,253	2,598	1,422	1,148	450	237	89	-
Yellow-poplar	38,756	1,261	947	2,996	4,674	4,432	6,073	3,034	6,804	8,139	396
Sassafras	48,629	9,978	13,373	9,354	7,388	4,675	2,780	706	-	375	-
Other hardwoods	30,453	7,471	8,315	5,876	4,175	1,431	2,196	363	-	626	-
Total hardwoods	19,072,815	2,150,154	2,931,226	3,390,106	3,036,134	2,419,188	1,823,210	1,251,395	762,731	1,117,195	191,476
All species	26,644,885	3,578,155	4,685,315	4,769,700	3,984,786	3,055,929	2,270,180	1,581,522	980,000	1,492,309	246,989

Table 13. -- Net volume of growing stock in the saw-log portion of sawtimber trees on timberland by species group and diameter class, Michigan, 1993

(In thousand cubic feet)

Species group	All classes	Diameter class (inches at breast height)							
		9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods									
Jack pine	254,513	125,085	82,882	30,775	11,180	3,975	390	226	-
Red pine	831,900	282,677	202,207	130,341	82,253	60,273	37,807	36,195	147
White pine	649,315	64,523	76,981	72,839	74,554	75,580	69,227	177,340	38,271
White spruce	327,905	72,398	81,858	65,763	47,510	33,433	14,072	12,615	256
Black spruce	88,622	49,832	23,061	7,424	3,636	3,437	984	248	-
Balsam fir	254,138	147,393	63,878	29,032	9,083	3,420	505	827	-
Hemlock	527,532	49,332	71,381	86,427	93,666	74,367	51,832	90,575	9,952
Tamarack	73,442	30,233	21,509	11,395	6,026	2,975	966	338	-
Eastern redcedar	780	374	156	114	-	-	-	136	-
Northern white-cedar	782,342	301,786	203,707	133,260	70,919	38,798	17,968	15,203	701
Other softwoods	39,286	22,659	10,334	3,280	2,418	-	595	-	-
Total softwoods	3,829,775	1,146,292	837,954	570,650	401,245	296,258	194,346	333,703	49,327
Hardwoods									
Select white oak	421,671	-	64,195	74,150	68,699	60,476	41,701	85,421	27,029
Select red oak	877,696	-	157,513	178,226	139,732	119,282	99,016	158,699	25,228
Other red oak	210,146	-	35,705	37,904	43,931	31,836	24,085	29,630	7,055
Select hickory	43,357	-	9,526	11,667	9,157	5,989	2,225	4,599	194
Other hickory	28,544	-	8,854	6,790	5,185	4,483	1,913	1,319	-
Basswood	401,013	-	131,074	101,088	71,427	42,581	25,124	27,098	2,621
Beech	261,616	-	38,330	43,199	49,338	43,287	28,272	53,325	5,865
Yellow birch	232,114	-	46,075	45,953	49,570	32,819	21,664	33,274	2,759
Hard maple	1,465,951	-	376,903	312,486	266,100	199,439	125,286	168,850	16,887
Soft maple	1,213,127	-	326,662	273,350	212,181	143,320	87,411	136,197	34,006
Elm	68,229	-	24,171	16,492	11,975	7,124	3,285	5,070	112
Black ash	76,056	-	28,438	24,770	11,490	5,840	2,729	2,789	-
White & green ash	357,015	-	79,795	79,053	70,808	52,768	26,726	40,985	6,880
Sycamore	16,464	-	1,495	1,378	559	2,705	602	6,471	3,254
Cottonwood	81,606	-	7,056	9,688	13,145	11,407	6,910	20,526	12,874
Willow	24,706	-	2,121	2,797	4,444	2,199	2,940	6,851	3,354
Hackberry	1,207	-	105	239	254	609	-	-	-
Balsam poplar	155,974	-	34,459	36,580	29,688	20,365	13,775	19,774	1,333
Bigtooth aspen	531,675	-	189,022	167,572	93,371	44,469	22,621	14,394	226
Quaking aspen	761,753	-	261,884	207,540	147,465	84,135	30,338	29,718	673
Paper birch	192,264	-	90,386	54,582	26,877	12,715	4,549	3,155	-
Tupelo	1,816	-	148	891	-	-	-	777	-
Black cherry	172,493	-	51,060	47,530	30,155	20,822	9,660	12,369	897
Black walnut	25,578	-	6,472	6,316	4,398	3,903	2,248	2,241	-
Butternut	4,346	-	1,764	1,067	890	361	194	70	-
Yellow-poplar	25,580	-	3,145	3,295	4,651	2,366	5,346	6,460	317
Sassafras	11,243	-	4,870	3,421	2,118	541	-	293	-
Other hardwoods	6,299	-	2,803	1,064	1,664	278	-	490	-
Total hardwoods	7,669,539	-	1,984,031	1,749,088	1,369,272	956,119	588,620	870,845	151,564
All species	11,499,314	1,146,292	2,821,985	2,319,738	1,770,517	1,252,377	782,966	1,204,548	200,891

Table 14. -- Net volume of sawtimber on timberland by species group and diameter class, Michigan, 1993

(In thousand board feet)[1]

Species group	All classes	Diameter class (inches at breast height)							
		9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods									
Jack pine	1,474,600	734,438	468,300	177,284	66,371	24,329	2,442	1,436	-
Red pine	4,791,938	1,619,442	1,125,667	740,158	481,306	362,361	232,787	229,239	978
White pine	3,973,439	380,321	432,791	416,845	439,977	459,582	431,862	1,151,747	260,314
White spruce	1,950,136	427,895	471,114	386,002	286,231	206,480	88,735	81,955	1,724
Black spruce	508,901	284,596	130,297	43,168	21,757	21,247	6,240	1,596	-
Balsam fir	1,481,028	867,587	362,501	167,584	53,946	20,920	3,144	5,346	-
Hemlock	3,154,012	296,485	401,993	492,117	548,237	447,829	319,990	580,126	67,235
Tamarack	430,682	177,311	123,604	66,873	36,261	18,353	6,085	2,195	-
Eastern redcedar	4,877	2,372	932	686	-	-	-	887	-
Northern white-cedar	4,696,896	1,855,182	1,187,143	780,451	423,767	236,723	111,943	96,994	4,693
Other softwoods	226,052	131,164	57,993	18,843	14,329	-	3,723	-	-
Total softwoods	22,692,561	6,776,793	4,762,335	3,290,011	2,372,182	1,797,824	1,206,951	2,151,521	334,944
Hardwoods									
Select white oak	2,659,883	-	404,673	452,678	421,129	376,346	263,891	556,890	184,276
Select red oak	5,513,432	-	990,813	1,086,603	857,056	743,410	627,608	1,035,653	172,289
Other red oak	1,320,026	-	227,519	232,046	269,803	198,223	152,316	192,380	47,739
Select hickory	271,408	-	60,942	71,368	56,283	37,400	14,097	29,991	1,327
Other hickory	178,167	-	55,992	41,575	31,879	28,011	12,107	8,603	-
Basswood	2,504,525	-	822,723	620,314	441,036	266,482	159,644	176,250	18,076
Beech	1,676,951	-	247,578	271,833	310,895	275,269	181,899	349,849	39,628
Yellow birch	1,473,171	-	296,534	286,510	309,417	206,865	138,172	216,997	18,676
Hard maple	9,282,920	-	2,408,570	1,941,376	1,658,768	1,257,683	800,316	1,101,775	114,432
Soft maple	7,708,538	-	2,096,255	1,701,152	1,323,657	903,931	558,722	891,484	233,337
Elm	431,468	-	155,606	102,275	74,275	44,646	20,911	33,005	750
Black ash	475,217	-	179,281	152,599	71,100	36,616	17,384	18,237	-
White & green ash	2,214,657	-	491,215	477,975	432,986	328,666	169,431	267,338	47,046
Sycamore	107,688	-	9,390	8,526	3,494	17,223	3,873	42,824	22,358
Cottonwood	520,161	-	44,855	59,183	80,417	70,717	43,507	133,799	87,683
Willow	157,770	-	13,622	17,102	27,161	13,619	18,529	44,853	22,884
Hackberry	7,544	-	680	1,472	1,582	3,810	-	-	-
Balsam poplar	977,493	-	216,198	224,399	183,664	127,623	87,830	128,711	9,068
Bigtooth aspen	3,293,765	-	1,174,224	1,024,055	576,740	279,196	144,315	93,715	1,520
Quaking aspen	4,736,558	-	1,635,170	1,270,987	911,209	527,802	193,049	193,754	4,587
Paper birch	1,209,190	-	573,710	338,108	167,374	80,286	29,127	20,585	-
Tupelo	11,271	-	911	5,397	-	-	-	4,963	-
Black cherry	1,087,087	-	326,243	295,115	187,520	130,868	61,506	79,857	5,978
Black walnut	160,994	-	41,074	39,126	27,372	24,517	14,321	14,584	-
Butternut	27,239	-	11,157	6,600	5,557	2,251	1,219	455	-
Yellow-poplar	162,735	-	19,716	20,229	28,842	14,943	34,267	42,586	2,152
Sassafras	69,742	-	30,660	20,837	12,949	3,369	-	1,927	-
Other hardwoods	39,053	-	17,519	6,460	10,168	1,727	-	3,179	-
Total hardwoods	48,278,653	-	12,552,830	10,775,900	8,482,333	6,001,499	3,748,041	5,684,244	1,033,806
All species	70,971,214	6,776,793	17,315,165	14,065,911	10,854,515	7,799,323	4,954,992	7,835,765	1,368,750

[1]International 1/4-inch rule.

Table 15. -- Net volume of sawtimber on timberland by species group, grade, diameter class, and Forest Survey Unit, Michigan, 1993

(In thousand board feet)[1]

Eastern Upper Peninsula

Species group	Log grade 1					Log grade 2					Log grade 3					Log grade 4				
		Diameter class (inches at breast height)					Diameter class (inches at breast height)					Diameter class (inches at breast height)					Diameter class (inches at breast height)			
	Total	9.0-14.9	15.0-18.9	19.0-20.9	21.0+	Total	9.0-14.9	15.0-18.9	19.0-20.9	21.0+	Total	9.0-14.9	15.0-18.9	19.0-20.9	21.0+	Total	9.0-14.9	15.0-18.9	19.0-20.9	21.0+
Softwoods																				
Jack pine	-	-	-	-	-	1,640	1,582	53	5	-	443,495	427,630	14,434	1,431	-	-	-	-	-	-
Red pine	13,476	1,510	7,374	4,592	-	35,835	16,156	16,577	3,102	-	1,061,372	820,962	164,805	65,638	9,967	-	-	-	-	-
White pine	201,314	2,154	40,898	74,513	83,749	260,120	71,630	76,780	42,072	69,638	405,560	150,866	92,400	90,214	72,080	203,755	96,098	42,341	22,643	42,673
White spruce	1,168	-	1,168	-	-	13,683	5,804	7,879	-	-	601,126	421,847	129,192	37,927	12,160	-	-	-	-	-
Black spruce	-	-	-	-	-	1,995	1,995	-	-	-	188,651	174,697	8,405	5,549	-	-	-	-	-	-
Balsam fir	-	-	-	-	-	-	-	-	-	-	457,685	423,974	31,207	2,504	-	-	-	-	-	-
Hemlock	48,238	-	20,331	18,155	9,752	113,228	22,477	46,735	35,368	8,648	633,790	308,809	169,107	69,341	86,533	-	-	-	-	-
Tamarack	-	-	-	-	-	13,906	5,892	8,014	-	-	101,506	99,190	-	2,316	-	-	-	-	-	-
Eastern redcedar	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northern white-ce	7,606	-	2,369	5,237	-	28,007	18,692	9,315	-	-	1,787,436	1,549,709	200,331	30,288	7,108	-	-	-	-	-
Other softwoods	-	-	-	-	-	-	-	-	-	-	15,212	14,682	530	-	-	-	-	-	-	-
Total	271,802	3,664	72,140	102,497	93,501	468,414	144,228	165,353	80,547	78,286	5,695,833	4,392,366	810,411	305,208	187,848	203,755	96,098	42,341	22,643	42,673

Species group	Tree grade 1					Tree grade 2					Tree grade 3					Tie and timber				
		Diameter class (inches at breast height)					Diameter class (inches at breast height)					Diameter class (inches at breast height)					Diameter class (inches at breast height)			
	Total	11.0-14.9	15.0-18.9	19.0-20.9	21.0+	Total	11.0-14.9	15.0-18.9	19.0-20.9	21.0+	Total	11.0-14.9	15.0-18.9	19.0-20.9	21.0+	Total	11.0-14.9	15.0-18.9	19.0-20.9	21.0+
Hardwoods																				
Select white oak	-	-	-	-	-	-	-	-	-	-	2,354	1,043	543	768	-	-	-	-	-	-
Select red oak	12,477	-	-	6,227	6,250	37,780	8,920	16,893	11,967	-	22,690	17,834	4,856	-	-	30,378	20,387	9,991	-	-
Other red oak	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Select hickory	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other hickory	-	-	-	-	-	-	-	-	-	-	1,138	341	-	-	797	-	-	-	-	-
Basswood	45,313	3,795	25,821	12,453	3,244	67,996	39,950	28,046	-	-	61,873	55,636	-	4,338	1,899	3,380	3,380	-	-	-
Beech	60,609	-	31,097	18,535	10,977	243,020	97,041	91,846	37,353	16,780	263,505	110,265	111,714	41,526	-	169,108	73,438	62,478	26,644	6,548
Yellow birch	42,561	-	28,063	11,239	3,259	125,591	38,665	50,096	27,588	9,242	143,256	80,693	46,437	9,618	6,508	30,392	11,865	7,007	3,975	7,545
Hard maple	173,006	-	76,495	74,289	22,224	586,972	196,329	266,042	64,892	57,709	763,961	573,429	143,294	47,258	-	181,132	132,489	39,514	9,129	-
Soft maple	85,239	-	54,244	27,874	3,121	350,576	146,652	169,229	25,414	9,281	622,620	415,094	116,114	78,525	12,887	204,652	133,963	40,509	16,145	14,015
Elm	-	-	-	-	-	6,792	-	5,514	1,137	141	13,939	8,739	-	4,629	571	-	-	-	-	-
Black ash	2,294	-	-	2,294	-	21,022	18,702	2,320	-	-	32,374	30,518	1,856	-	-	5,135	-	5,135	-	-
White & green as	43,021	-	26,353	11,896	4,772	18,290	18,290	-	-	-	31,607	23,493	8,114	-	-	3,084	3,084	-	-	-
Sycamore	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cottonwood	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2,442	362	2,080	-	-
Willow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	485	-	485	-	-
Hackberry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Balsam poplar	29,486	-	18,354	4,678	6,454	115,006	52,875	49,368	12,763	-	156,469	114,944	26,182	15,343	-	70,261	49,741	12,976	7,544	-
Bigtooth aspen	26,628	-	13,659	12,580	389	38,133	8,510	29,272	-	351	97,426	83,874	-	12,543	1,009	25,487	10,487	14,768	-	232
Quaking aspen	80,605	-	56,680	10,916	13,009	272,405	136,747	112,986	22,672	-	417,696	326,490	73,847	17,359	-	136,160	107,833	28,327	-	-
Paper birch	8,884	-	4,346	4,498	40	91,907	56,047	35,448	-	412	209,839	196,930	11,969	-	940	44,256	34,063	9,995	-	198
Tupelo	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Black cherry	2,477	-	2,356	104	17	54,369	36,650	15,060	2,269	370	60,826	47,612	10,261	2,540	413	6,158	3,422	2,437	257	42
Black walnut	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Butternut	-	-	-	-	-	677	-	677	-	-	1,866	1,204	662	-	-	-	-	-	-	-
Yellow-poplar	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sassafras	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other hardwoods	-	-	-	-	-	145	145	-	-	-	401	401	-	-	-	-	-	-	-	-
Total	612,602	3,795	337,468	197,583	73,756	2,030,661	857,523	872,817	206,055	94,286	2,903,860	2,088,540	555,849	234,447	25,024	912,510	584,534	235,702	63,694	28,580
All species	884,404	7,459	409,608	300,080	167,257	2,499,095	1,001,751	1,038,170	286,602	172,572	8,599,693	6,480,906	1,366,260	539,655	212,872	1,116,265	680,632	278,043	86,337	71,253

(Table 15 continued on next page)

(Table 15 continued)

Western Upper Peninsula

Species group	Log grade 1					Log grade 2					Log grade 3					Log grade 4				
		Diameter class (inches at breast height)					Diameter class (inches at breast height)					Diameter class (inches at breast height)					Diameter class (inches at breast height)			
	Total	9.0-14.9	15.0-18.9	19.0-20.9	21.0+	Total	9.0-14.9	15.0-18.9	19.0-20.9	21.0+	Total	9.0-14.9	15.0-18.9	19.0-20.9	21.0+	Total	9.0-14.9	15.0-18.9	19.0-20.9	21.0+
Softwoods																				
Jack pine	-	-	-	-	-	6,789	6,759	-	30	-	335,350	283,399	50,575	1,376	-	-	-	-	-	-
Red pine	122,273	40,644	61,703	19,926	-	32,941	8,164	17,320	4,181	3,276	411,443	326,579	28,377	35,821	20,666	-	-	-	-	-
White pine	161,695	4,788	43,296	37,272	76,339	297,139	74,320	69,027	60,749	93,043	528,244	131,231	120,617	149,384	127,012	81,858	23,021	10,989	22,281	25,567
White spruce	-	-	-	-	-	25,210	6,685	2,421	1,706	14,398	1,096,882	697,207	312,818	86,857	-	-	-	-	-	-
Black spruce	-	-	-	-	-	-	-	-	-	-	253,541	223,324	27,933	2,284	-	-	-	-	-	-
Balsam fir	-	-	-	-	-	-	-	-	-	-	772,432	733,265	33,181	2,593	3,393	-	-	-	-	-
Hemlock	28,113	-	11,743	5,113	11,257	170,664	20,241	62,011	64,713	23,699	1,709,947	603,190	564,457	328,416	213,884	-	-	-	-	-
Tamarack	-	-	-	-	-	12,715	6,085	3,253	3,266	111	146,139	120,626	23,300	1,187	1,026	-	-	-	-	-
Eastern redcedar	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northern white-ce	-	-	-	-	-	32,149	20,184	11,965	-	-	1,573,703	1,109,016	320,146	118,690	25,851	-	-	-	-	-
Other softwoods	-	-	-	-	-	-	-	-	-	-	3,679	3,099	580	-	-	-	-	-	-	-
Total	312,081	45,432	116,742	62,311	87,596	577,607	142,438	165,997	134,645	134,527	6,831,360	4,230,936	1,481,984	726,608	391,832	81,858	23,021	10,989	22,281	25,567

Species group	Tree grade 1					Tree grade 2					Tree grade 3					Tie and timber				
		Diameter class (inches at breast height)					Diameter class (inches at breast height)					Diameter class (inches at breast height)					Diameter class (inches at breast height)			
	Total	11.0-14.9	15.0-18.9	19.0-20.9	21.0+	Total	11.0-14.9	15.0-18.9	19.0-20.9	21.0+	Total	11.0-14.9	15.0-18.9	19.0-20.9	21.0+	Total	11.0-14.9	15.0-18.9	19.0-20.9	21.0+
Hardwoods																				
Select white oak	-	-	-	-	-	-	-	-	-	-	2,739	2,739	-	-	-	-	-	-	-	-
Select red oak	78,664	-	22,052	36,138	20,474	113,354	38,026	55,404	17,507	2,417	150,210	103,056	30,318	11,290	5,546	28,862	12,688	16,174	-	-
Other red oak	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Select hickory	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other hickory	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Basswood	141,463	4,154	91,959	30,587	14,763	223,562	136,230	67,072	14,270	5,990	394,264	342,018	35,389	16,857	-	21,633	18,048	3,585	-	-
Beech	204	-	204	-	-	322	-	322	-	-	567	127	440	-	-	31	31	-	-	-
Yellow birch	167,822	-	84,886	52,916	30,018	248,273	104,283	100,635	37,156	6,199	529,378	248,151	138,084	80,730	62,413	38,293	24,097	14,196	-	-
Hard maple	639,399	-	323,565	187,167	128,667	1,437,841	474,455	606,494	305,149	51,743	2,264,556	1,445,418	495,603	234,419	89,116	343,750	183,324	84,157	48,191	28,078
Soft maple	79,902	-	48,066	16,269	15,565	357,882	184,506	136,706	36,670	-	985,290	638,560	254,750	79,963	11,977	137,286	81,848	21,456	9,563	24,417
Elm	115,494	47,458	39,975	14,396	13,665	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Black ash	17,344	-	15,692	-	1,652	68,702	38,412	20,034	10,256	-	111,163	99,266	11,897	-	-	3,916	3,916	-	-	-
White & green as	32,370	-	18,883	13,487	-	52,604	31,826	20,778	-	-	39,006	39,006	-	-	-	-	-	-	-	-
Sycamore	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cottonwood	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Willow	485	485	-	-	-	787	251	536	-	-	584	128	456	-	-	-	-	-	-	-
Hackberry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Balsam poplar	49,337	-	25,124	15,614	8,599	58,125	17,513	19,995	13,700	6,917	67,815	44,161	15,236	6,130	2,286	7,922	7,922	-	-	-
Bigtooth aspen	77,573	-	65,352	12,221	-	139,382	72,629	45,659	21,094	-	202,987	148,776	35,982	6,297	11,942	13,469	13,469	-	-	-
Quaking aspen	59,463	-	47,922	10,914	627	317,086	146,720	141,057	25,074	4,235	1,263,772	822,724	341,543	81,293	18,212	176,914	155,350	20,742	-	2,822
Paper birch	16,694	-	11,509	4,961	224	129,579	75,543	44,294	7,805	2,137	280,138	236,260	38,974	-	4,904	23,764	20,288	3,060	-	416
Tupelo	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Black cherry	3,242	-	3,242	-	-	42,169	28,432	9,502	3,677	556	51,793	47,438	4,355	-	-	8,957	1,422	7,535	-	-
Black walnut	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Butternut	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellow-poplar	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sassafras	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other hardwoods	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	1,479,456	52,097	798,435	394,670	234,254	3,189,666	1,348,826	1,268,486	492,158	80,196	6,344,282	4,217,846	1,403,029	516,989	206,396	805,817	522,423	170,907	57,754	55,733
All species	1,791,537	97,529	915,177	456,981	321,850	3,767,275	1,491,264	1,434,485	626,803	214,723	13,175,622	8,448,784	2,885,013	1,243,597	598,228	888,675	545,444	181,896	80,035	81,300

(Table 15 continued on next page)

(Table 15 continued)

Northern Lower Peninsula

Species group	Log grade 1					Log grade 2					Log grade 3					Log grade 4				
		Diameter class (inches at breast height)					Diameter class (inches at breast height)					Diameter class (inches at breast height)					Diameter class (inches at breast height)			
	Total	9.0-14.9	15.0-18.9	19.0-20.9	21.0+	Total	9.0-14.9	15.0-18.9	19.0-20.9	21.0+	Total	9.0-14.9	15.0-18.9	19.0-20.9	21.0+	Total	9.0-14.9	15.0-18.9	19.0-20.9	21.0+
Softwoods																				
Jack pine	3,103	3,103	-	-	-	-	-	-	-	-	650,667	624,071	25,560	1,036	-	-	-	-	-	-
Red pine	124,513	7,323	64,072	45,473	7,645	167,108	61,441	83,885	16,099	5,683	2,537,323	1,971,140	349,706	180,780	35,697	-	-	-	-	-
White pine	150,692	4,870	47,642	28,705	69,475	309,296	97,367	67,075	85,777	59,077	738,021	330,741	165,897	127,084	114,299	198,567	71,448	45,956	41,205	39,958
White spruce	10,471	-	10,036	182	253	23,970	22,323	-	691	956	153,284	116,766	26,743	4,101	5,674	-	-	-	-	-
Black spruce	-	-	-	-	-	2,675	2,675	-	-	-	62,039	55,375	6,664	-	-	-	-	-	-	-
Balsam fir	-	-	-	-	-	10,514	10,514	-	-	-	238,394	227,898	10,496	-	-	-	-	-	-	-
Hemlock	10,217	-	2,950	7,267	-	35,806	4,294	12,452	-	19,060	363,458	182,525	93,264	54,378	33,291	-	-	-	-	-
Tamarack	2,980	-	2,962	-	18	5,091	5,044	-	-	47	112,474	100,047	11,425	-	1,002	-	-	-	-	-
Eastern redcedar	-	-	-	-	-	106	106	-	-	-	2,560	1,708	-	852	-	-	-	-	-	-
Northern white-ce	-	-	-	-	-	49,694	37,080	7,212	4,076	1,326	1,200,993	1,070,769	108,235	21,989	-	-	-	-	-	-
Other softwoods	-	-	-	-	-	-	-	-	-	-	110,789	109,609	1,180	-	-	-	-	-	-	-
Total	301,976	15,296	127,662	81,627	77,391	604,260	240,844	170,624	106,643	86,149	6,170,002	4,790,649	799,170	390,220	189,963	198,567	71,448	45,956	41,205	39,958

Species group	Tree grade 1					Tree grade 2					Tree grade 3					Tie and timber				
		Diameter class (inches at breast height)					Diameter class (inches at breast height)					Diameter class (inches at breast height)					Diameter class (inches at breast height)			
	Total	11.0-14.9	15.0-18.9	19.0-20.9	21.0+	Total	11.0-14.9	15.0-18.9	19.0-20.9	21.0+	Total	11.0-14.9	15.0-18.9	19.0-20.9	21.0+	Total	11.0-14.9	15.0-18.9	19.0-20.9	21.0+
Hardwoods																				
Select white oak	75,402	-	31,851	29,931	13,620	257,849	116,936	97,584	24,391	18,938	431,975	269,294	105,900	31,767	25,014	142,263	82,183	40,183	19,897	-
Select red oak	547,704	-	203,967	200,016	143,721	1,162,142	439,916	386,959	239,279	95,988	1,206,011	757,539	265,055	120,041	63,376	374,081	250,585	78,515	25,861	19,120
Other red oak	30,560	-	12,801	14,111	3,648	88,610	19,215	43,226	14,732	11,437	274,393	98,822	88,376	54,572	32,623	185,623	115,308	55,992	11,899	2,424
Select hickory	166	166	-	-	-	481	481	-	-	-	1,490	1,490	-	-	-	1,008	328	-	680	-
Other hickory	170	170	-	-	-	494	494	-	-	-	1,530	950	-	580	-	1,035	930	-	105	-
Basswood	188,250	4,933	141,212	34,955	7,150	509,486	355,710	130,979	14,843	7,954	442,583	380,606	21,458	32,446	8,073	8,584	8,584	-	-	-
Beech	102,442	-	36,745	45,364	20,333	261,551	38,670	105,467	68,425	48,989	251,514	115,567	97,295	25,433	13,219	16,660	12,598	-	4,062	-
Yellow birch	14,741	-	8,770	5,971	-	32,558	16,898	13,039	2,621	-	61,905	53,103	5,315	-	3,487	9,059	-	9,059	-	-
Hard maple	232,304	-	120,353	72,752	39,199	654,060	352,912	260,792	40,356	-	1,116,202	876,780	126,075	53,550	59,797	189,982	127,858	40,562	21,562	-
Soft maple	270,837	-	125,752	51,972	93,113	767,959	341,485	310,892	80,605	34,977	1,348,004	962,472	236,657	120,697	28,178	234,102	131,742	67,027	21,012	14,321
Elm	16,481	-	10,258	1,493	4,730	25,981	24,411	-	1,570	-	4,687	4,403	-	284	-	-	-	-	-	-
Black ash	2,296	2,066	-	157	73	37,540	22,435	12,061	2,075	969	50,390	38,209	7,582	3,135	1,464	4,522	4,069	-	309	144
White & green as	213,794	7,343	153,253	44,163	9,035	304,583	158,409	115,164	18,437	12,573	297,266	228,383	29,469	26,843	12,571	14,646	1,621	12,447	-	578
Sycamore	1,608	-	702	906	-	2,290	-	1,090	1,200	-	2,235	-	1,091	1,144	-	110	110	-	-	-
Cottonwood	45,504	-	-	15,053	30,451	13,405	1,981	9,856	1,568	-	8,758	6,940	-	1,818	-	2,336	2,336	-	-	-
Willow	3,759	-	3,759	-	-	14,108	2,324	8,125	-	3,659	7,566	4,291	-	-	3,275	5,557	402	693	4,462	-
Hackberry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Balsam poplar	61,693	-	24,666	34,629	2,398	106,789	44,611	51,802	-	10,376	177,575	155,337	-	-	22,238	47,551	13,747	29,559	-	4,245
Bigtooth aspen	116,555	-	85,931	30,624	-	731,559	466,123	232,820	32,616	-	1,351,424	1,049,445	229,036	46,450	26,493	196,481	140,156	37,104	19,221	-
Quaking aspen	99,611	-	64,208	14,862	20,541	545,815	254,359	237,449	54,007	-	1,005,605	739,945	189,280	57,407	18,973	231,052	180,416	50,636	-	-
Paper birch	5,774	-	5,774	-	-	78,805	47,604	31,201	-	-	263,593	222,459	24,256	16,878	-	31,302	13,608	17,694	-	-
Tupelo	29	29	-	-	-	392	392	-	-	-	1,309	1,309	-	-	-	156	156	-	-	-
Black cherry	56,609	-	39,407	15,325	1,877	75,586	50,235	21,098	-	4,253	153,242	129,066	14,942	-	9,234	17,602	16,503	-	-	1,099
Black walnut	-	-	-	-	-	3,703	675	3,028	-	-	-	-	-	-	-	-	-	-	-	-
Butternut	-	-	-	-	-	-	-	-	-	-	1,706	706	1,000	-	-	-	-	-	-	-
Yellow-poplar	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sassafras	-	-	-	-	-	5,590	3,953	1,637	-	-	4,833	3,418	1,415	-	-	-	-	-	-	-
Other hardwoods	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	2,086,289	14,707	1,069,409	612,284	389,889	5,681,336	2,760,229	2,074,269	596,725	250,113	8,465,796	6,100,534	1,444,202	593,045	328,015	1,713,712	1,103,240	439,471	129,070	41,931
All species	2,388,265	30,003	1,197,071	693,911	467,280	6,285,596	3,001,073	2,244,893	703,368	336,262	14,635,798	10,891,183	2,243,372	983,265	517,978	1,912,279	1,174,688	485,427	170,275	81,889

(Table 15 continued on next page)

(Table 15 continued)

Southern Lower Peninsula

Species group	Log grade 1					Log grade 2					Log grade 3					Log grade 4				
		Diameter class (inches at breast height)					Diameter class (inches at breast height)					Diameter class (inches at breast height)					Diameter class (inches at breast height)			
	Total	9.0-14.9	15.0-18.9	19.0-20.9	21.0+	Total	9.0-14.9	15.0-18.9	19.0-20.9	21.0+	Total	9.0-14.9	15.0-18.9	19.0-20.9	21.0+	Total	9.0-14.9	15.0-18.9	19.0-20.9	21.0+
Softwoods																				
Jack pine	-	-	-	-	-	-	-	-	-	-	33,556	33,556	-	-	-	-	-	-	-	-
Red pine	-	-	-	-	-	-	-	-	-	-	285,654	257,505	28,149	-	-	-	-	-	-	-
White pine	25,364	-	6,477	-	18,887	20,484	20,484	-	-	-	330,785	145,608	58,134	66,792	60,251	60,545	31,805	11,140	17,600	-
White spruce	-	-	-	-	-	-	-	-	-	-	24,342	24,342	-	-	-	-	-	-	-	-
Black spruce	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Balsam fir	-	-	-	-	-	290	290	-	-	-	1,713	1,713	-	-	-	-	-	-	-	-
Hemlock	-	-	-	-	-	5,876	-	2,949	-	2,927	34,675	10,671	2,970	7,039	13,995	-	-	-	-	-
Tamarack	-	-	-	-	-	22,577	20,449	2,128	-	-	13,294	13,294	-	-	-	-	-	-	-	-
Eastern redcedar	-	-	-	-	-	-	-	-	-	-	2,211	2,211	-	-	-	-	-	-	-	-
Northern white-ce	-	-	-	-	-	-	-	-	-	-	17,308	16,086	1,222	-	-	-	-	-	-	-
Other softwoods	-	-	-	-	-	-	-	-	-	-	96,372	80,610	12,039	3,723	-	-	-	-	-	-
Total	25,364	-	6,477	-	18,887	49,227	41,223	5,077	-	2,927	839,910	585,596	102,514	77,554	74,246	60,545	31,805	11,140	17,600	-

Species group	Tree grade 1					Tree grade 2					Tree grade 3					Tie and timber				
		Diameter class (inches at breast height)					Diameter class (inches at breast height)					Diameter class (inches at breast height)					Diameter class (inches at breast height)			
	Total	11.0-14.9	15.0-18.9	19.0-20.9	21.0+	Total	11.0-14.9	15.0-18.9	19.0-20.9	21.0+	Total	11.0-14.9	15.0-18.9	19.0-20.9	21.0+	Total	11.0-14.9	15.0-18.9	19.0-20.9	21.0+
Hardwoods																				
Select white oak	325,170	-	98,441	89,467	137,262	569,874	91,848	172,751	121,921	183,354	655,556	220,753	180,417	130,118	124,268	196,701	77,505	69,841	24,336	25,019
Select red oak	398,618	-	69,931	151,342	177,345	462,392	114,043	155,262	127,732	65,355	533,336	214,466	156,260	54,649	107,961	354,733	167,979	121,185	53,150	12,419
Other red oak	129,416	-	37,099	62,286	30,031	225,124	49,303	90,583	55,007	30,231	229,675	91,110	90,798	15,742	32,025	156,625	83,794	49,041	13,301	10,489
Select hickory	38,409	-	13,529	24,880	-	77,533	38,724	38,809	-	-	101,769	59,331	28,832	-	13,606	50,552	35,457	15,095	-	-
Other hickory	31,764	-	30,959	-	805	48,636	40,507	6,607	-	1,522	56,219	45,315	9,156	-	1,748	37,181	18,554	5,185	12,430	1,012
Basswood	136,601	-	54,138	62,320	20,143	144,253	89,747	54,506	-	-	115,284	59,512	13,829	10,133	31,810	-	-	-	-	-
Beech	88,249	-	-	-	88,249	100,463	-	28,782	39,794	31,887	101,362	32,796	13,698	18,456	36,412	17,344	2,227	6,823	4,800	3,494
Yellow birch	-	-	-	-	-	3,892	2,673	-	573	646	20,711	14,220	-	3,050	3,441	4,739	-	3,997	349	393
Hard maple	303,208	-	149,943	96,129	57,136	177,106	79,665	36,083	46,049	15,309	171,030	71,342	49,379	24,552	25,757	48,389	31,182	9,335	-	7,872
Soft maple	767,385	-	321,157	212,952	233,276	583,327	155,307	185,071	107,358	135,591	677,993	270,280	178,309	100,326	129,078	235,484	117,518	49,207	38,364	30,395
Elm	11,799	-	11,176	623	-	49,029	29,445	17,467	2,117	-	163,200	121,550	31,442	6,725	3,483	24,066	18,198	4,890	978	-
Black ash	-	-	-	-	-	51,290	26,589	19,919	1,895	2,887	63,359	45,425	11,767	2,445	3,722	3,870	3,459	-	163	248
White & green as	307,010	-	149,123	110,865	47,022	417,129	168,304	142,095	35,550	71,180	356,020	280,525	52,164	14,486	8,845	84,227	41,727	18,949	-	23,551
Sycamore	26,488	-	1,913	3,291	21,284	36,332	7,677	28,655	-	-	32,590	20,737	-	11,853	-	6,035	4,125	1,910	-	-
Cottonwood	93,142	-	25,818	14,066	53,258	101,562	13,848	45,718	41,996	-	201,283	48,737	42,225	21,358	88,963	51,729	28,368	19,868	3,493	-
Willow	5,020	-	-	-	5,020	45,854	2,749	12,661	7,651	22,793	48,051	25,615	10,525	11,911	-	25,514	8,318	12,340	4,856	-
Hackberry	1,198	-	1,198	-	-	2,176	989	612	575	-	2,960	2,960	-	-	-	1,210	560	650	-	-
Balsam poplar	6,734	-	1,393	1,918	3,423	3,970	1,981	838	1,151	-	15,105	7,537	3,184	4,384	-	3,655	1,824	770	1,061	-
Bigtooth aspen	-	-	-	-	-	45,743	32,992	11,631	591	529	127,472	93,730	30,590	1,663	1,489	103,426	85,453	15,259	1,432	1,282
Quaking aspen	13,499	-	9,099	4,400	-	11,173	8,096	3,077	-	-	64,121	41,439	20,423	-	2,259	39,581	28,680	10,901	-	-
Paper birch	-	-	-	-	-	-	-	-	-	-	24,655	18,176	4,626	1,853	-	-	-	-	-	-
Tupelo	-	-	-	-	-	-	-	-	-	-	9,385	4,422	-	2,435	2,528	-	-	-	-	-
Black cherry	76,641	-	46,650	27,752	2,239	167,670	89,449	48,093	24,898	5,230	283,032	186,390	69,538	18,037	9,067	26,714	18,098	-	7,828	788
Black walnut	31,645	-	22,056	9,589	-	71,144	42,234	20,310	6,004	2,596	49,118	28,446	8,770	6,598	5,304	5,384	5,384	-	-	-
Butternut	-	-	-	-	-	19,167	12,120	5,614	1,433	-	3,823	3,577	-	246	-	-	-	-	-	-
Yellow-poplar	27,454	-	6,205	9,059	12,190	86,263	32,081	28,355	25,827	-	44,381	14,667	13,026	12,161	4,527	4,637	2,018	525	2,094	-
Sassafras	8,289	-	8,242	-	47	11,602	4,296	7,245	-	61	39,428	37,712	-	-	1,716	-	-	-	-	-
Other hardwoods	4,502	-	4,401	-	101	7,426	6,838	-	223	365	24,643	13,810	8,787	780	1,266	1,936	964	810	61	101
Total	2,832,241	-	1,062,471	880,939	888,831	3,520,130	1,141,505	1,160,744	648,345	569,536	4,215,561	2,074,580	1,027,745	473,961	639,275	1,483,732	781,392	416,581	168,696	117,063
All species	2,857,605	-	1,068,948	880,939	907,718	3,569,357	1,182,728	1,165,821	648,345	572,463	5,055,471	2,660,176	1,130,259	551,515	713,521	1,544,277	813,197	427,721	186,296	117,063

(Table 15 continued on next page)

(Table 15 continued)

All Units

Species group	Log grade 1 Total	Log grade 1 Diameter class (inches at breast height) 9.0-14.9	15.0-18.9	19.0-20.9	21.0+	Log grade 2 Total	Log grade 2 Diameter class (inches at breast height) 9.0-14.9	15.0-18.9	19.0-20.9	21.0+	Log grade 3 Total	Log grade 3 Diameter class (inches at breast height) 9.0-14.9	15.0-18.9	19.0-20.9	21.0+	Log grade 4 Total	Log grade 4 Diameter class (inches at breast height) 9.0-14.9	15.0-18.9	19.0-20.9	21.0+
Softwoods																				
Jack pine	3,103	3,103	-	-	-	8,429	8,341	53	35	-	1,463,068	1,366,656	90,569	3,843	-	-	-	-	-	-
Red pine	260,262	49,477	133,149	69,991	7,645	235,884	85,761	117,782	23,382	8,959	4,295,792	3,376,186	571,037	282,239	66,330	-	-	-	-	-
White pine	539,085	11,812	138,313	140,490	248,450	887,039	263,801	212,862	188,598	221,758	2,002,610	758,446	437,048	433,474	373,642	544,725	222,372	110,426	103,729	108,196
White spruce	11,639	-	11,204	182	253	62,863	34,812	10,300	2,397	15,354	1,875,634	1,260,162	468,753	128,885	17,834	-	-	-	-	-
Black spruce	-	-	-	-	-	4,670	4,670	-	-	-	504,231	453,396	43,002	7,833	-	-	-	-	-	-
Balsam fir	-	-	-	-	-	10,804	10,804	-	-	-	1,470,224	1,386,850	74,884	5,097	3,393	-	-	-	-	-
Hemlock	86,568	-	35,024	30,535	21,009	325,574	47,012	124,147	100,081	54,334	2,741,870	1,105,195	829,798	459,174	347,703	-	-	-	-	-
Tamarack	2,980	-	2,962	-	18	54,289	37,470	13,395	3,266	158	373,413	333,157	34,725	3,503	2,028	-	-	-	-	-
Eastern redcedar	-	-	-	-	-	106	106	-	-	-	4,771	3,919	-	852	-	-	-	-	-	-
Northern white-ce	7,606	-	2,369	5,237	-	109,850	75,956	28,492	4,076	1,326	4,579,440	3,745,580	629,934	170,967	32,959	-	-	-	-	-
Other softwoods	-	-	-	-	-	-	-	-	-	-	226,052	208,000	14,329	3,723	-	-	-	-	-	-
Total	911,223	64,392	323,021	246,435	277,375	1,699,508	568,733	507,051	321,835	301,889	19,537,105	13,999,547	3,194,079	1,499,590	843,889	544,725	222,372	110,426	103,729	108,196

Species group	Tree grade 1 Total	Tree grade 1 Diameter class (inches at breast height) 11.0-14.9	15.0-18.9	19.0-20.9	21.0+	Tree grade 2 Total	Tree grade 2 Diameter class (inches at breast height) 11.0-14.9	15.0-18.9	19.0-20.9	21.0+	Tree grade 3 Total	Tree grade 3 Diameter class (inches at breast height) 11.0-14.9	15.0-18.9	19.0-20.9	21.0+	Tie and timber Total	Tie and timber Diameter class (inches at breast height) 11.0-14.9	15.0-18.9	19.0-20.9	21.0+
Hardwoods																				
Select white oak	400,572	-	130,292	119,398	150,882	827,723	208,784	270,335	146,312	202,292	1,092,624	493,829	286,860	162,653	149,282	338,964	159,686	110,024	44,233	25,019
Select red oak	1,037,463	-	295,950	393,723	347,790	1,775,668	600,905	614,518	396,485	163,760	1,912,247	1,092,895	456,489	185,960	176,883	788,054	451,639	225,865	79,011	31,539
Other red oak	159,976	-	49,900	76,397	33,679	313,734	68,518	133,809	69,739	41,668	504,068	189,932	179,174	70,314	64,648	342,248	199,102	105,033	25,200	12,913
Select hickory	38,575	166	13,529	24,880	-	78,014	39,205	38,809	-	-	103,259	60,821	28,832	-	13,606	51,560	35,785	15,095	680	-
Other hickory	31,934	170	30,959	-	805	49,130	41,001	6,607	-	1,522	58,887	46,606	9,156	580	2,545	38,216	19,484	5,185	12,535	1,012
Basswood	511,627	12,882	313,130	140,315	45,300	945,297	621,637	280,603	29,113	13,944	1,014,004	837,772	70,676	63,774	41,782	33,597	30,012	3,585	-	-
Beech	251,504	-	68,046	63,899	119,559	605,356	135,711	226,417	145,572	97,656	616,948	258,755	223,147	85,415	49,631	203,143	86,294	69,301	35,506	10,042
Yellow birch	225,124	-	121,721	70,126	33,277	410,314	162,519	163,770	67,938	16,087	755,250	396,167	189,836	93,398	75,849	82,483	35,962	34,259	4,324	7,938
Hard maple	1,347,919	-	670,356	430,337	247,226	2,855,979	1,105,361	1,169,411	456,446	124,761	4,315,769	2,966,969	814,351	359,779	174,670	763,253	474,853	173,568	78,882	35,950
Soft maple	1,203,363	-	549,221	309,067	345,075	2,059,744	827,950	801,898	250,047	179,849	3,633,907	2,286,426	785,830	379,531	182,120	811,524	465,091	178,201	85,084	83,148
Elm	143,774	47,458	61,409	16,512	18,395	81,802	53,856	22,981	4,824	141	181,826	134,692	31,442	11,638	4,054	24,066	18,198	4,890	978	-
Black ash	21,934	2,066	15,692	2,451	1,725	178,554	106,138	54,334	14,226	3,856	257,286	213,418	33,102	5,580	5,186	17,443	11,444	5,135	472	392
White & green as	596,195	7,343	347,612	180,411	60,829	792,606	376,829	278,037	53,987	83,753	723,899	571,407	89,747	41,329	21,416	101,957	46,432	31,396	-	24,129
Sycamore	28,096	-	2,615	4,197	21,284	38,622	7,677	29,745	1,200	-	34,825	20,737	1,091	12,997	-	6,145	4,235	1,910	-	-
Cottonwood	138,646	-	25,818	29,119	83,709	114,967	15,829	55,574	43,564	-	210,041	55,677	42,225	23,176	88,963	56,507	31,066	21,948	3,493	-
Willow	9,264	485	3,759	-	5,020	60,749	5,324	21,322	7,651	26,452	56,201	30,034	10,981	11,911	3,275	31,556	8,720	13,518	9,318	-
Hackberry	1,198	-	1,198	-	-	2,176	989	612	575	-	2,960	2,960	-	-	-	1,210	560	650	-	-
Balsam poplar	147,250	-	69,537	56,839	20,874	283,890	116,980	122,003	27,614	17,293	416,964	321,979	44,604	25,857	24,524	129,389	73,234	43,305	8,605	4,245
Bigtooth aspen	220,756	-	164,942	55,425	389	954,817	580,254	319,382	54,301	880	1,779,309	1,375,825	295,608	66,943	40,933	338,883	249,585	67,131	20,653	1,514
Quaking aspen	253,178	-	177,909	41,092	34,177	1,146,479	545,922	494,569	101,753	4,235	2,751,194	1,930,598	625,093	156,059	39,444	585,707	472,279	110,606	-	2,822
Paper birch	31,352	-	21,629	9,459	264	300,291	179,194	110,943	7,605	2,549	778,225	673,825	79,825	18,731	5,844	99,322	67,959	30,749	-	614
Tupelo	29	29	-	-	-	392	392	-	-	-	10,694	5,731	-	2,435	2,528	156	156	-	-	-
Black cherry	138,969	-	91,655	43,181	4,133	339,794	204,766	93,773	30,844	10,411	548,893	410,506	99,096	20,577	18,714	59,431	39,445	9,972	8,085	1,929
Black walnut	31,645	-	22,056	9,589	-	74,847	42,909	23,338	6,004	2,596	49,118	28,446	8,770	6,598	5,304	5,384	5,384	-	-	-
Butternut	-	-	-	-	-	19,844	12,120	6,291	1,433	-	7,395	5,487	1,662	246	-	-	-	-	-	-
Yellow-poplar	27,454	-	6,205	9,059	12,190	86,263	32,081	28,355	25,827	-	44,381	14,667	13,026	12,161	4,527	4,637	2,018	525	2,094	-
Sassafras	8,289	-	8,242	-	47	17,192	8,249	8,882	-	61	44,261	41,130	1,415	-	1,716	-	-	-	-	-
Other hardwoods	4,502	-	4,401	-	101	7,571	6,983	-	223	365	25,044	14,211	8,787	780	1,266	1,936	964	810	61	101
Total	7,010,588	70,599	3,267,783	2,085,476	1,586,730	14,421,815	6,108,083	5,376,318	1,943,283	994,131	21,929,479	14,481,502	4,430,825	1,818,442	1,198,710	4,916,771	2,991,589	1,262,661	419,214	243,307
All species	7,921,811	134,991	3,590,804	2,331,911	1,864,105	16,121,323	6,676,816	5,883,369	2,265,118	1,296,020	41,466,584	28,481,049	7,624,904	3,318,032	2,042,599	5,461,496	3,213,961	1,373,087	522,943	351,505

[1] International 1/4 inch rule.

Table 16. -- Net volume of growing stock and sawtimber on timberland by Forest Survey Unit, county, and major species group, Michigan, 1993

Forest Survey Unit and county	Growing stock					Sawtimber				
		Major species group					Major species group			
	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods
	(In thousand cubic feet)					(In thousand board feet) [1]				
Eastern Upper Peninsula										
Alger	777,861	106,117	175,612	205,299	290,833	2,345,044	489,646	609,315	439,866	806,217
Chippewa	922,711	147,032	280,529	344,852	150,298	2,308,928	469,880	684,915	786,966	367,167
Delta	757,000	88,993	258,431	285,629	123,947	1,707,669	287,591	567,439	541,152	311,487
Luce	644,572	116,655	185,141	177,821	164,955	1,946,852	458,659	565,027	411,700	511,466
Mackinac	709,893	76,119	252,370	252,420	128,984	1,742,564	331,437	615,298	481,897	313,932
Menominee	647,139	34,015	240,771	228,782	143,571	1,308,806	140,463	477,790	388,861	301,692
Schoolcraft	644,812	120,699	193,382	201,590	129,141	1,739,594	464,103	478,241	422,711	374,539
Total	5,103,988	689,630	1,586,236	1,696,393	1,131,729	13,099,457	2,641,779	3,998,025	3,473,153	2,986,500
Western Upper Peninsula										
Baraga	843,163	25,937	210,326	250,288	356,612	2,579,752	117,222	779,882	637,683	1,044,965
Dickinson	584,033	32,995	170,765	252,266	128,007	1,346,871	142,933	403,266	594,774	205,898
Gogebic	948,485	36,313	249,353	293,108	369,711	2,460,645	136,997	885,805	636,386	801,457
Houghton	904,393	56,574	168,574	302,426	376,819	2,558,956	229,250	647,751	702,168	979,787
Iron	912,694	56,781	205,869	323,197	326,847	2,427,592	252,405	626,444	747,762	800,981
Keweenaw	331,297	20,899	106,283	96,870	107,245	958,909	99,911	341,495	221,508	295,995
Marquette	1,571,937	187,389	437,549	520,824	426,175	4,348,659	810,762	1,338,643	1,076,708	1,122,546
Ontonagon	1,088,163	47,752	212,780	445,838	381,793	2,941,725	188,252	801,888	1,034,969	916,616
Total	7,184,165	464,640	1,761,499	2,484,817	2,473,209	19,623,109	1,977,732	5,825,174	5,651,958	6,168,245
Northern Lower Peninsula										
Alcona	489,698	59,631	59,388	216,855	153,824	1,276,067	175,619	142,225	527,916	430,307
Alpena	308,377	32,395	86,524	155,077	34,381	747,372	131,415	179,072	347,224	89,661
Antrim	333,367	18,831	27,500	158,855	128,181	743,042	46,614	89,229	355,776	251,423
Arenac	145,505	12,838	5,236	96,214	31,217	364,939	44,301	10,940	215,052	94,646
Bay	56,318	-	-	46,683	9,635	130,943	-	-	98,551	32,392
Benzie	225,371	42,803	13,158	76,065	93,345	563,958	73,967	34,406	207,102	248,483
Charlevoix	373,313	33,571	73,446	122,610	143,686	1,025,708	138,400	188,316	336,287	362,705
Cheboygan	437,126	66,354	66,205	190,445	114,122	1,028,314	216,281	164,779	447,880	199,374
Clare	328,363	54,546	14,033	165,869	93,915	818,238	149,140	31,626	327,092	310,380
Crawford	305,347	103,661	16,343	74,003	111,340	717,265	329,082	30,555	115,870	241,758
Emmet	369,457	19,984	35,514	144,519	169,440	893,012	77,759	80,956	370,216	364,081
Gladwin	212,002	18,463	3,669	157,635	32,235	498,114	60,462	7,451	341,742	88,459
Grand Traverse	271,775	93,864	24,997	85,924	66,990	603,683	131,380	63,450	212,887	195,966
Iosco	313,397	91,258	45,304	129,187	47,648	801,111	256,874	110,922	321,952	111,363
Isabella	141,812	6,209	6,291	84,282	45,030	401,141	8,850	14,284	212,105	165,902
Kalkaska	375,036	117,683	27,663	114,165	115,525	797,283	241,100	74,723	246,036	235,424
Lake	441,897	123,828	17,381	104,441	196,247	1,250,368	369,629	35,086	233,427	612,226
Leelanau	175,649	24,605	11,282	34,261	105,501	500,634	57,235	30,981	89,816	322,602
Manistee	368,393	73,384	14,208	131,178	149,623	963,333	144,587	39,771	341,116	437,859
Mason	235,118	51,614	3,158	93,139	87,207	602,150	84,716	9,488	227,985	279,961
Mecosta	211,754	23,458	15,861	121,864	50,571	533,837	84,068	38,610	267,522	143,637
Midland	229,882	13,175	4,068	158,814	53,825	601,748	58,691	11,470	376,609	154,978
Missaukee	296,677	51,617	40,260	137,513	67,287	703,572	150,421	96,589	268,108	188,454
Montmorency	341,804	63,149	37,738	137,348	103,569	825,677	233,152	69,434	260,461	262,630
Newaygo	540,658	103,935	15,055	185,833	235,835	1,595,786	282,791	50,189	512,132	750,674
Oceana	242,483	44,143	12,468	97,797	88,075	635,282	110,186	36,792	213,814	274,490
Ogemaw	287,607	41,682	25,304	146,543	74,078	630,710	90,276	46,565	332,816	161,053
Osceola	228,470	19,015	31,191	105,284	72,980	627,896	45,643	103,585	253,561	225,107
Oscoda	312,463	103,203	16,583	99,300	93,377	863,005	343,613	33,112	208,316	277,964
Otsego	379,135	53,606	32,616	136,147	156,766	803,661	140,808	74,955	293,463	294,435
Presque Isle	376,369	52,351	111,121	155,461	57,436	855,698	199,149	245,737	298,774	112,038
Roscommon	353,659	58,334	56,638	124,193	114,494	922,614	222,194	97,927	263,740	338,753
Wexford	413,444	142,443	27,500	110,204	133,297	895,777	283,529	49,648	251,405	311,195
Total	10,121,726	1,815,633	977,703	4,097,708	3,230,682	25,221,938	4,961,932	2,292,873	9,376,753	8,570,380

(Table 16 continued on next page)

(Table 16 continued)

Forest Survey Unit and county	Growing stock					Sawtimber				
		Major species group					Major species group			
	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods
	(In thousand cubic feet)					*(In thousand board feet)* [1]				
Southern Lower Peninsula										
Allegan	288,664	24,446	927	99,042	163,792	915,568	80,687	4,012	298,248	532,621
Barry	188,908	8,255	3,477	68,076	109,100	615,876	28,180	9,239	179,094	399,363
Berrien	140,413	3,784	544	75,391	60,694	480,145	8,510	3,035	248,863	219,737
Branch	88,461	211	174	57,418	30,658	281,880	-	932	183,744	97,204
Calhoun	166,146	2,410	-	93,764	69,972	506,899	10,850	-	217,753	278,296
Cass	133,519	945	406	64,078	68,090	447,233	3,077	2,064	202,384	239,708
Clinton	58,400	-	-	40,966	17,434	141,197	-	-	104,660	36,537
Eaton	116,019	975	-	59,975	55,069	306,002	2,585	-	158,091	145,326
Genesee	74,295	-	-	29,745	44,550	235,007	-	-	79,746	155,261
Gratiot	71,764	3,064	-	34,662	34,038	211,308	8,471	-	98,445	104,392
Hillsdale	81,904	8,382	170	26,760	46,592	249,331	26,321	-	64,468	158,542
Huron	77,426	-	866	59,341	17,219	212,598	-	-	161,239	51,359
Ingham	79,607	513	855	39,340	38,899	245,674	2,407	4,455	117,640	121,172
Ionia	91,406	1,660	3,536	40,766	45,444	253,950	5,036	2,732	82,920	163,262
Jackson	122,578	2,275	165	36,967	83,171	401,393	5,563	-	94,366	301,464
Kalamazoo	115,629	19,144	1,271	58,836	36,378	360,820	73,469	3,234	184,457	99,660
Kent	211,556	13,079	250	86,884	111,343	639,037	58,874	-	217,632	362,531
Lapeer	120,494	16,253	3,544	50,895	49,802	341,043	33,617	14,375	127,632	165,419
Lenawee	94,475	-	1,515	42,076	50,884	274,333	-	1,787	102,078	170,468
Livingston	139,327	11,968	-	47,905	79,454	484,771	46,317	-	134,005	304,449
Macomb	52,108	-	2,763	27,568	21,777	155,569	-	6,210	70,925	78,434
Monroe	66,164	-	-	20,533	45,631	210,369	-	-	73,214	137,155
Montcalm	186,282	24,505	5,522	75,612	80,078	546,684	93,965	16,783	188,700	247,236
Muskegon	227,741	42,569	3,682	68,731	111,370	724,717	170,644	18,045	206,092	329,936
Oakland	127,158	1,514	293	48,586	76,765	383,490	7,083	-	101,011	275,396
Ottawa	112,721	18,815	1,781	42,189	49,170	361,539	58,271	7,731	113,269	182,268
Saginaw	114,969	7,045	-	50,639	57,285	315,243	27,096	-	99,972	188,175
St. Clair	160,466	10,226	1,185	58,376	90,316	497,791	54,596	5,015	170,531	267,649
St. Joseph	103,800	1,051	3,609	43,628	55,512	331,433	4,319	4,733	116,889	205,492
Sanilac	69,122	1,081	804	47,569	19,668	146,959	2,522	2,412	89,018	53,007
Shiawassee	92,292	-	-	42,391	49,901	326,005	-	-	140,275	185,730
Tuscola	127,122	1,761	4,189	84,124	36,869	314,352	6,982	9,016	188,519	109,835
Van Buren	163,593	7,754	-	71,490	84,349	497,213	32,818	-	172,410	291,985
Washtenaw	122,168	-	1,516	30,378	90,274	442,787	-	6,976	74,511	361,300
Wayne	52,028	-	-	22,856	29,172	168,494	-	-	53,584	114,910
Total	4,235,006	233,685	43,044	1,847,557	2,110,720	13,026,710	852,260	122,786	4,916,385	7,135,279
All counties	26,644,885	3,203,588	4,368,482	10,126,475	8,946,340	70,971,214	10,453,703	12,238,858	23,418,249	24,860,404

[1] International 1/4-inch rule.

Table 17. -- Net volume of all live trees and salvable dead trees on timberland by class of timber and major species group, Michigan, 1993

(In thousand cubic feet)

Class of timber	All species	Major species group			
		Pine	Other softwoods	Soft hardwoods	Hard hardwoods
Live trees					
Growing stock trees					
Sawtimber					
Saw-log portion	11,499,314	1,772,858	2,056,917	3,728,309	3,941,230
Upper stem portion	3,491,995	244,129	316,076	1,463,992	1,467,798
Total	14,991,309	2,016,987	2,372,993	5,192,301	5,409,028
Poletimber	11,653,576	1,186,601	1,995,489	4,934,174	3,537,312
All growing-stock trees	26,644,885	3,203,588	4,368,482	10,126,475	8,946,340
Cull trees					
Short-log trees	581,364	27,538	72,235	217,672	263,919
Rough trees [1]					
Sawtimber size	754,569	58,595	105,959	282,878	307,137
Poletimber size	841,416	43,997	92,132	352,049	353,238
Total	1,595,985	102,592	198,091	634,927	660,375
Rotten trees [1]					
Sawtimber size	355,541	4,259	75,108	156,091	120,083
Poletimber size	105,309	951	19,704	57,230	27,424
Total	460,850	5,210	94,812	213,321	147,507
All cull trees	2,638,199	135,340	365,138	1,065,920	1,071,801
Salvable dead trees					
Sawtimber size	144,043	12,221	41,016	62,635	28,171
Poletimber size	99,515	7,008	20,360	57,629	14,518
All salvable dead trees	243,558	19,229	61,376	120,264	42,689
All classes	29,526,642	3,358,157	4,794,996	11,312,659	10,060,830

[1]Includes all noncommercial species.

Table 18. -- Net volume of all live trees and growing-stock trees on timberland by ownership class and major species group, Michigan, 1993

(In thousand cubic feet)

	All live trees					Growing-stock trees				
		Major species group					Major species group			
Ownership class	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods
National forest	3,903,696	892,661	660,047	1,179,611	1,171,377	3,527,999	871,557	607,989	1,029,115	1,019,338
Other federal	80,575	18,034	12,341	29,769	20,431	74,392	17,538	11,549	27,267	18,038
State	5,341,522	960,778	1,049,628	1,968,045	1,363,071	4,907,405	921,827	970,087	1,784,898	1,230,593
County and municip	418,327	69,197	46,564	142,603	159,963	379,496	66,758	42,220	128,456	142,062
Indian	27,958	-	4,462	11,642	11,854	26,492	-	4,417	11,022	11,053
Forest industry	2,610,652	74,070	754,252	729,072	1,053,258	2,335,644	72,208	691,597	647,633	924,206
Individual	13,483,957	1,046,601	1,590,663	5,857,081	4,989,612	12,293,004	987,558	1,472,278	5,340,814	4,492,354
Corporate	3,416,397	277,587	615,663	1,274,572	1,248,575	3,100,453	266,142	568,345	1,157,270	1,108,696
All ownerships	29,283,084	3,338,928	4,733,620	11,192,395	10,018,141	26,644,885	3,203,588	4,368,482	10,126,475	8,946,340

Table 19. -- Net volume of growing stock on timberland by forest type group/local type and major species group, Michigan, 1993

(In thousand cubic feet)

Forest type group/ local type	All species	Major species group			
		Pine	Other softwoods	Soft hardwoods	Hard hardwoods
Softwood type groups					
White-red-jack pine					
Jack pine	730,408	623,723	18,041	42,701	45,943
Red pine	1,612,009	1,426,478	25,610	85,803	74,118
White pine	398,749	280,006	35,312	53,264	30,167
Total	2,741,166	2,330,207	78,963	181,768	150,228
Spruce-fir					
Balsam fir	625,706	47,342	375,049	183,543	19,772
White spruce	164,440	14,875	100,129	46,271	3,165
Black spruce	325,813	46,252	243,038	35,970	553
Northern white-cedar	2,029,869	65,894	1,610,870	315,756	37,349
Tamarack	97,986	3,349	86,410	7,688	539
Total	3,243,814	177,712	2,415,496	589,228	61,378
All softwood types	5,984,980	2,507,919	2,494,459	770,996	211,606
Hardwood type groups					
Oak-hickory					
Oak-hickory	2,949,259	162,534	12,650	588,994	2,185,081
Elm-ash-cottonwood					
Elm-ash-soft maple	2,046,580	32,702	240,246	1,422,208	351,424
Maple-beech-birch					
Maple-beech-birch	11,805,898	327,567	135,495	4,452,403	5,890,433
Aspen-birch					
Aspen	3,165,070	146,286	334,189	2,412,676	271,919
Paper birch	479,231	24,225	94,496	327,802	32,708
Balsam poplar	212,663	1,303	56,902	151,289	3,169
Total	3,856,964	171,814	485,587	2,891,767	307,796
All hardwood types	20,658,701	694,617	1,873,978	9,355,372	8,734,734
Nonstocked	1,204	1,052	45	107	-
All forest types	26,644,885	3,203,588	4,368,482	10,126,475	8,946,340

Table 20. -- Average net annual growth of growing stock and sawtimber on timberland by Forest Survey Unit, county, and major species group, Michigan, 1980-1992

Forest Survey Unit and county	Growing stock					Sawtimber				
		Major species group					Major species group			
	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods
	(In thousand cubic feet)					*(In thousand board feet)* [1]				
Eastern Upper Peninsula										
Alger	19,075	3,522	3,849	4,266	7,438	74,644	18,766	17,227	13,238	25,413
Chippewa	23,302	5,420	6,081	7,488	4,313	84,349	20,776	22,055	28,896	12,622
Delta	21,143	3,479	8,019	6,734	2,911	68,816	13,087	24,563	20,170	10,996
Luce	14,122	3,842	2,385	3,936	3,959	58,552	18,110	10,975	14,328	15,139
Mackinac	17,046	2,855	5,116	5,293	3,782	65,205	14,175	21,672	18,144	11,214
Menominee	19,560	1,623	7,374	6,394	4,169	53,636	7,120	18,908	15,124	12,484
Schoolcraft	17,600	4,638	5,034	4,802	3,126	60,834	19,879	15,191	15,220	10,544
Total	131,848	25,379	37,858	38,913	29,698	466,036	111,913	130,591	125,120	98,412
Western Upper Peninsula										
Baraga	16,583	896	3,541	4,390	7,756	65,259	4,220	16,224	18,367	26,448
Dickinson	15,053	1,364	3,715	6,184	3,790	55,520	6,798	15,700	23,050	9,972
Gogebic	22,246	1,633	4,368	6,637	9,608	79,429	6,561	24,240	24,595	24,033
Houghton	21,061	1,616	3,637	6,624	9,184	80,839	8,949	18,569	24,336	28,985
Iron	21,850	2,073	4,223	6,847	8,707	86,179	8,703	19,824	30,773	26,879
Keweenaw	5,746	640	1,379	1,617	2,110	23,321	3,438	6,294	5,706	7,883
Marquette	37,826	5,630	8,921	13,582	9,693	136,146	26,447	34,723	43,684	31,292
Ontonagon	25,832	1,678	4,638	10,144	9,372	95,231	7,119	24,019	39,301	24,792
Total	166,197	15,530	34,422	56,025	60,220	621,924	72,235	159,593	209,812	180,284

(Table 20 continued on next page)

(Table 20 continued)

Forest Survey Unit and county	Growing stock					Sawtimber				
		Major species group					Major species group			
	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods
	(In thousand cubic feet)					*(In thousand board feet)* [1]				
Northern Lower Peninsula										
Alcona	13,059	2,887	1,091	5,070	4,011	53,502	9,024	3,962	21,857	18,659
Alpena	8,793	1,037	2,631	4,020	1,105	27,192	3,953	6,253	13,108	3,878
Antrim	10,413	963	748	4,389	4,313	31,438	2,868	3,106	14,892	10,572
Arenac	4,684	352	237	3,122	973	18,850	2,233	704	11,338	4,575
Bay	2,021	-	-	1,569	452	9,215	-	-	7,524	1,691
Benzie	7,783	2,332	371	2,332	2,748	24,978	5,966	818	8,461	9,733
Charlevoix	8,870	817	2,051	2,172	3,830	33,631	4,375	5,891	10,819	12,546
Cheboygan	13,593	2,892	1,706	5,099	3,896	41,475	9,499	5,398	16,828	9,750
Clare	10,111	2,019	85	5,830	2,177	35,154	7,513	788	16,157	10,696
Crawford	8,700	2,936	357	2,252	3,155	32,323	13,963	1,432	5,628	11,300
Emmet	10,718	1,320	598	3,631	5,169	38,291	6,566	1,726	14,055	15,944
Gladwin	7,362	943	82	5,234	1,103	24,275	2,602	375	16,899	4,399
Grand Traverse	8,823	4,699	543	1,512	2,069	22,809	7,266	2,312	5,540	7,691
Iosco	8,836	3,185	990	3,302	1,359	36,899	14,426	3,173	13,765	5,535
Isabella	4,926	273	150	2,895	1,608	19,919	648	674	11,643	6,954
Kalkaska	12,977	5,590	694	3,172	3,521	34,863	11,767	3,176	10,415	9,505
Lake	13,529	4,932	564	3,032	5,001	52,344	17,764	1,670	11,055	21,855
Leelanau	5,718	1,499	295	1,121	2,803	19,701	4,315	1,014	3,213	11,159
Manistee	11,185	3,418	314	3,549	3,904	37,914	9,834	1,145	12,035	14,900
Mason	8,196	3,038	112	3,110	1,936	30,615	8,721	414	11,573	9,907
Mecosta	8,307	1,286	647	4,497	1,877	23,908	4,669	2,136	12,025	5,078
Midland	7,467	442	107	5,217	1,701	27,728	2,032	646	19,527	5,523
Missaukee	11,808	2,705	1,343	5,453	2,307	30,441	7,099	4,099	12,399	6,844
Montmorency	10,502	2,197	549	4,596	3,160	34,439	8,371	1,747	12,155	12,166
Newaygo	15,606	4,464	205	5,371	5,566	61,067	15,205	1,829	18,918	25,115
Oceana	7,810	1,622	411	3,183	2,594	26,458	6,230	1,515	7,744	10,969
Ogemaw	10,016	2,560	662	4,467	2,327	28,499	3,305	1,686	15,253	8,255
Osceola	7,635	1,263	579	3,746	2,047	24,409	3,787	2,884	9,463	8,275
Oscoda	10,442	4,280	659	2,846	2,657	36,290	14,044	1,293	8,807	12,146
Otsego	11,390	2,348	959	3,270	4,813	33,205	6,438	1,937	10,815	14,015
Presque Isle	9,922	1,576	2,765	3,802	1,779	32,111	7,132	8,078	12,169	4,732
Roscommon	8,091	1,227	1,311	2,879	2,674	35,703	6,364	3,621	11,292	14,426
Wexford	15,053	6,458	1,067	3,606	3,922	41,732	16,391	3,291	9,815	12,235
Total	314,346	77,560	24,883	119,346	92,557	1,061,378	244,370	78,793	397,187	341,028

(Table 20 continued on next page)

(Table 20 continued)

Forest Survey Unit and county	Growing stock					Sawtimber				
	All species	Major species group				All species	Major species group			
		Pine	Other softwoods	Soft hardwoods	Hard hardwoods		Pine	Other softwoods	Soft hardwoods	Hard hardwoods
	(in thousand cubic feet)					(In thousand board feet) [1]				
Southern Lower Peninsula										
Allegan	9,057	812	34	3,591	4,620	34,946	4,188	110	12,872	17,776
Barry	5,860	340	245	2,381	2,894	23,728	1,759	791	6,963	14,215
Berrien	4,683	290	12	2,520	1,861	18,462	650	77	9,335	8,400
Branch	2,510	17	1	1,635	857	9,601	-	5	6,755	2,841
Calhoun	5,805	143	-	3,624	2,038	21,138	688	-	12,529	7,921
Cass	3,338	-10	10	1,577	1,761	12,779	251	57	5,715	6,756
Clinton	2,068	-	-	1,433	635	7,152	-	-	6,020	1,132
Eaton	4,794	50	-	2,331	2,413	13,770	218	-	6,413	7,139
Genesee	2,658	-	-	1,259	1,399	9,071	-	-	3,338	5,733
Gratiot	2,511	134	-	1,229	1,148	10,065	359	-	5,097	4,609
Hillsdale	4,401	741	8	1,507	2,145	15,108	3,896	-	3,718	7,494
Huron	3,044	-	55	2,217	772	11,829	-	-	8,737	3,092
Ingham	3,152	52	53	1,690	1,357	11,567	116	374	5,636	5,441
Ionia	3,926	133	367	1,887	1,539	10,728	845	241	3,501	6,141
Jackson	3,737	152	36	1,372	2,177	14,500	434	-	3,852	10,214
Kalamazoo	4,130	606	86	2,078	1,360	12,033	2,633	254	5,934	3,212
Kent	7,561	678	51	2,936	3,896	27,008	3,286	-	8,703	15,019
Lapeer	5,922	971	588	2,716	1,647	18,811	2,449	1,019	8,906	6,437
Lenawee	2,840	-	22	1,505	1,313	9,498	-	22	4,121	5,355
Livingston	4,884	497	-	2,148	2,239	17,880	2,488	-	6,680	8,712
Macomb	1,968	-	92	1,106	770	5,096	-	115	2,776	2,205
Monroe	2,045	-	-	677	1,368	7,041	-	-	2,713	4,328
Montcalm	6,482	974	-15	2,780	2,743	23,282	4,649	513	7,731	10,389
Muskegon	6,874	1,666	102	2,133	2,973	27,224	6,835	880	6,902	12,607
Oakland	4,733	74	73	2,362	2,224	13,673	390	-	4,701	8,582
Ottawa	4,085	684	54	1,786	1,561	14,916	2,473	282	4,589	7,572
Saginaw	3,986	357	-	1,998	1,631	11,662	1,441	-	4,947	5,274
St. Clair	5,060	227	47	1,876	2,910	17,310	1,339	169	6,182	9,620
St. Joseph	3,227	70	254	1,428	1,475	11,785	261	395	4,163	6,966
Sanilac	3,037	138	58	1,971	870	7,495	212	480	3,610	3,193
Shiawassee	3,105	-	-	1,567	1,538	12,746	-	-	5,426	7,320
Tuscola	5,708	145	75	3,670	1,818	14,835	173	497	9,319	4,846
Van Buren	5,505	278	-	2,831	2,396	19,654	1,673	-	7,722	10,259
Washtenaw	3,321	-	53	1,210	2,058	12,832	-	315	3,516	9,001
Wayne	2,007	-	-	1,025	982	6,625	-	-	2,781	3,844
Total	148,024	10,219	2,361	70,056	65,388	515,850	43,706	6,596	211,903	253,645
All counties	760,415	128,688	99,524	284,340	247,863	2,665,188	472,224	375,573	944,022	873,369

[1] International 1/4-inch rule.

Table 21. -- Average annual removals of growing stock and sawtimber on timberland by Forest Survey Unit, county, and major species group, Michigan, 1980-1992

Forest Survey Unit and county	Growing stock					Sawtimber				
		Major species group					Major species group			
	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods
	(In thousand cubic feet)					(In thousand board feet) [1]				
Eastern Upper Peninsula										
Alger	10,019	1,980	1,741	1,689	4,609	36,516	5,937	6,639	4,159	19,781
Chippewa	8,902	1,050	3,975	2,337	1,540	20,263	2,802	7,697	3,764	6,000
Delta	8,762	1,143	3,134	3,842	643	20,938	1,586	9,836	7,547	1,969
Luce	7,353	330	1,523	1,906	3,594	27,663	1,463	4,726	4,413	17,061
Mackinac	6,551	1,776	1,480	2,213	1,082	13,280	3,940	3,075	2,950	3,315
Menominee	6,863	631	2,280	3,195	757	13,246	2,759	4,877	4,859	751
Schoolcraft	6,512	1,385	1,827	2,494	806	18,079	4,736	4,591	6,602	2,150
Total	54,962	8,295	15,960	17,676	13,031	149,985	23,223	41,441	34,294	51,027
Western Upper Peninsula										
Baraga	11,271	194	2,217	3,707	5,153	44,502	851	10,490	10,427	22,734
Dickinson	4,090	72	821	3,166	31	4,372	200	1,423	2,749	-
Gogebic	6,590	545	285	3,174	2,586	21,618	2,193	1,154	9,822	8,449
Houghton	7,690	429	1,108	2,709	3,444	26,578	1,027	4,188	6,331	15,032
Iron	15,248	1,404	3,573	7,474	2,797	47,918	7,593	10,225	19,678	10,422
Keweenaw	1,661	250	83	744	584	5,049	1,382	143	1,072	2,452
Marquette	23,905	3,717	5,467	9,052	5,669	77,512	16,597	18,332	21,057	21,526
Ontonagon	12,075	86	645	6,691	4,653	36,811	427	2,252	16,236	17,896
Total	82,530	6,697	14,199	36,717	24,917	264,360	30,270	48,207	87,372	98,511
Northern Lower Peninsula										
Alcona	4,124	447	47	1,857	1,773	10,043	1,796	78	4,036	4,133
Alpena	4,654	65	521	3,563	505	9,889	368	1,723	7,118	680
Antrim	2,044	-	-	584	1,460	5,505	-	-	1,304	4,201
Arenac	1,020	21	62	762	175	2,111	-	-	1,700	411
Bay	894	-	-	807	87	2,175	-	-	2,117	58
Benzie	3,081	19	19	1,792	1,251	9,520	-	-	4,814	4,706
Charlevoix	4,314	1,495	906	1,680	233	11,168	4,944	1,164	4,216	844
Cheboygan	2,970	212	230	2,186	342	4,892	854	512	3,045	481
Clare	3,117	308	50	2,661	98	9,145	1,271	-	7,450	424
Crawford	3,501	545	-	1,342	1,614	4,913	1,697	-	1,903	1,313
Emmet	3,997	1,319	108	1,437	1,133	11,135	4,404	500	4,164	2,067
Gladwin	2,932	30	-	2,845	57	7,816	48	-	7,509	259
Grand Traverse	1,034	327	-	359	348	2,153	-	-	466	1,687
Iosco	2,305	674	177	1,113	341	6,312	1,379	497	3,730	706
Isabella	389	-	42	245	102	742	-	226	85	431
Kalkaska	2,616	1,624	106	631	255	8,979	6,390	237	1,366	986
Lake	5,817	1,620	13	1,879	2,305	9,824	2,086	-	3,522	4,216
Leelanau	1,172	192	136	311	533	4,367	1,042	320	942	2,063
Manistee	2,977	1,036	-	595	1,346	7,501	2,807	-	1,308	3,386
Mason	2,320	356	234	1,433	297	4,871	1,239	949	1,656	1,027
Mecosta	917	-	19	767	131	2,212	-	98	1,872	242
Midland	1,475	-	-	1,440	35	1,921	-	-	1,759	162
Missaukee	877	204	-	492	181	2,185	82	-	1,369	734
Montmorency	3,056	1,291	54	1,269	442	6,961	2,494	202	2,790	1,475
Newaygo	6,771	1,060	-	3,251	2,460	18,037	2,727	-	6,326	8,984
Oceana	2,507	308	18	1,140	1,041	8,046	768	94	3,263	3,921
Ogemaw	5,077	901	106	2,487	1,583	11,016	1,466	-	5,733	3,817
Osceola	4,026	240	-	3,605	181	9,077	-	-	8,634	443
Oscoda	4,811	2,850	128	835	998	9,008	4,353	160	1,692	2,803
Otsego	4,643	834	13	1,825	1,971	11,714	2,145	67	2,837	6,665
Presque Isle	4,490	131	2,122	2,179	58	9,705	730	3,714	5,261	-
Roscommon	3,147	1,120	272	1,271	484	8,274	4,196	275	2,690	1,113
Wexford	4,843	1,828	6	2,261	748	8,525	2,664	-	3,992	1,869
Total	101,918	21,057	5,389	50,904	24,568	239,742	51,950	10,816	110,669	66,307

(Table 21 continued on next page)

(Table 21 continued)

Forest Survey Unit and county	Growing stock					Sawtimber				
	All species	Major species group				All species	Major species group			
		Pine	Other softwoods	Soft hardwoods	Hard hardwoods		Pine	Other softwoods	Soft hardwoods	Hard hardwoods
	(In thousand cubic feet)					*(In thousand board feet)* [1]				
Southern Lower Peninsula										
Allegan	2,377	1,482	-	323	572	9,598	6,547	-	1,265	1,786
Barry	2,061	71	-	226	1,764	8,761	393	-	579	7,789
Berrien	258	-	-	258	-	1,318	-	-	1,318	-
Branch	306	-	-	306	-	812	-	-	812	-
Calhoun	537	-	-	478	59	1,912	-	-	1,912	-
Cass	181	-	-	181	-	203	-	-	203	-
Clinton	-	-	-	-	-	-	-	-	-	-
Eaton	1,103	-	-	552	551	3,448	-	-	1,437	2,011
Genesee	410	-	-	141	269	1,575	-	-	513	1,062
Gratiot	1,164	-	-	772	392	5,230	-	-	3,721	1,509
Hillsdale	67	-	-	32	35	181	-	-	-	181
Huron	581	-	-	511	70	1,455	-	-	1,455	-
Ingham	1,161	-	-	650	511	4,474	-	-	2,231	2,243
Ionia	283	-	-	152	131	1,231	-	-	803	428
Jackson	627	-	-	55	572	3,116	-	-	277	2,839
Kalamazoo	238	-	-	-	238	1,107	-	-	-	1,107
Kent	1,520	-	-	235	1,285	5,033	-	-	203	4,830
Lapeer	988	-	-	592	396	2,811	-	-	1,899	912
Lenawee	245	-	-	83	162	1,152	-	-	401	751
Livingston	1,698	-	-	667	1,031	5,553	-	-	2,023	3,530
Macomb	293	-	-	293	-	994	-	-	994	-
Monroe	509	-	-	419	90	2,400	-	-	1,971	429
Montcalm	3,898	74	22	1,880	1,922	12,165	398	-	5,690	6,077
Muskegon	3,680	2,429	-	676	575	12,072	8,368	-	1,505	2,199
Oakland	532	-	-	239	293	1,741	-	-	581	1,160
Ottawa	2,243	430	30	570	1,213	7,620	1,108	79	2,102	4,331
Saginaw	563	-	-	329	234	506	-	-	506	-
St. Clair	476	-	-	50	426	1,953	-	-	214	1,739
St. Joseph	624	-	-	45	579	2,797	-	-	219	2,578
Sanilac	-	-	-	-	-	-	-	-	-	-
Shiawassee	2,120	-	-	575	1,545	9,248	-	-	2,479	6,769
Tuscola	2,063	-	-	1,110	953	5,259	-	-	1,977	3,282
Van Buren	487	-	-	228	259	2,057	-	-	768	1,289
Washtenaw	1,097	-	-	454	643	2,797	-	-	606	2,191
Wayne	516	-	-	142	374	1,855	-	-	541	1,314
Total	34,906	4,486	52	13,224	17,144	122,434	16,814	79	41,205	64,336
All counties	274,316	40,535	35,600	118,521	79,660	776,521	122,257	100,543	273,540	280,181

[1]International 1/4-inch rule.

Table 22. -- Average net annual growth and average annual removals of growing stock and sawtimber on timberland by species group, Michigan, 1980-1992

Species group	Growing stock		Sawtimber	
	Average net annual growth	Average annual removals	Average net annual growth	Average annual removals
	(In thousand cubic feet)		*(In thousand board feet)* [1]	
Softwoods				
Jack pine	12,211	13,276	55,552	28,863
Red pine	78,310	15,980	242,699	43,445
White pine	32,518	10,283	157,432	48,878
White spruce	19,649	6,037	80,833	23,813
Black spruce	3,410	3,566	5,797	5,702
Balsam fir	12,484	9,284	46,338	18,380
Hemlock	12,256	4,426	70,789	21,981
Tamarack	4,481	288	16,116	827
Eastern redcedar	230	-	409	-
Northern white-ced	46,202	11,999	154,262	29,840
Other softwoods	6,461	996	17,570	1,071
Total softwoods	228,212	76,135	847,797	222,800
Hardwoods				
Select white oak	18,733	6,002	82,414	17,442
Other white oak	25	-	-	-
Select red oak	44,236	17,249	209,222	56,421
Other red oak	10,180	3,806	44,620	13,332
Select hickory	1,965	324	7,286	1,032
Other hickory	1,691	464	6,708	2,058
Basswood	20,084	5,903	88,004	21,742
Beech	13,694	5,660	54,064	23,163
Yellow birch	4,448	5,271	18,897	22,882
Hard maple	113,964	34,553	325,416	127,649
Soft maple	108,225	25,883	313,574	60,633
Elm	7,415	2,614	11,101	5,249
Black ash	8,383	2,252	13,625	3,623
White & green ash	33,068	5,536	110,735	15,328
Sycamore	456	133	2,735	732
Cottonwood	5,224	1,209	24,403	5,459
Willow	773	264	3,906	700
Hackberry	173	-	301	-
Balsam poplar	6,181	3,054	21,811	9,112
Bigtooth aspen	40,817	26,186	162,687	62,897
Quaking aspen	57,148	34,166	207,715	76,560
Paper birch	13,196	13,076	41,988	17,102
Tupelo	293	33	713	78
Black cherry	14,445	3,523	44,469	8,546
Black walnut	1,758	76	6,549	387
Butternut	195	-	954	-
Yellow-poplar	1,332	225	6,036	1,107
Sassafras	2,191	528	4,451	373
Other hardwoods	1,910	191	3,007	114
Total hardwoods	532,203	198,181	1,817,391	553,721
All species	760,415	274,316	2,665,188	776,521

[1]International 1/4-inch rule.

Table 23. -- Average annual mortality of growing stock and sawtimber on timberland by species group, Michigan, 1980-1992

Species group	Growing stock average annual mortality	Sawtimber average annual mortality
	(In thousand cubic feet)	*(In thousand board feet)* [1]
Softwoods		
Jack pine	11,201	23,515
Red pine	577	1,809
White pine	2,229	9,403
White spruce	5,302	20,782
Black spruce	7,841	12,537
Balsam fir	26,038	45,547
Hemlock	2,558	12,073
Tamarack	1,710	3,985
Eastern redcedar	1	8
Northern white-cedar	4,356	13,365
Other softwoods	432	112
Total softwoods	62,245	143,136
Hardwoods		
Select white oak	984	3,166
Select red oak	6,664	13,412
Other red oak	1,879	4,445
Select hickory	444	1,376
Other hickory	290	799
Basswood	4,053	11,289
Beech	856	2,883
Yellow birch	6,860	22,260
Hard maple	8,868	21,450
Soft maple	10,789	23,506
Elm	14,286	28,641
Black ash	3,188	4,549
White & green ash	2,832	5,729
Sycamore	26	44
Cottonwood	350	1,333
Willow	433	1,331
Hackberry	12	6
Balsam poplar	8,258	23,419
Bigtooth aspen	13,711	30,575
Quaking aspen	37,265	74,557
Paper birch	11,119	14,699
River birch	6	30
Tupelo	7	7
Black cherry	2,221	1,834
Black walnut	182	740
Butternut	71	174
Yellow-poplar	63	146
Sassafras	370	409
Other hardwoods	161	41
Total hardwoods	136,248	292,850
All species	198,493	435,986

[1]International 1/4-inch rule.

Table 24. -- Average net annual growth and average annual removals of growing stock and sawtimber on timberland by ownership class and major species group, Michigan, 1980-1992

Ownership class	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods
	Average net annual growth of growing stock				
		Major species group			
	(In thousand cubic feet)				
National forest	92,661	34,126	11,738	22,660	24,137
Other federal	2,158	584	364	661	549
State	141,963	34,255	21,045	51,262	35,401
County and municipal	11,259	3,066	833	3,478	3,882
Indian	476	-	100	219	157
Forest industry	52,122	2,538	12,754	14,230	22,600
Individual	379,665	44,959	41,127	161,911	131,668
Corporate	80,111	9,160	11,563	29,919	29,469
All ownerships	760,415	128,688	99,524	284,340	247,863
	Average annual removals of growing stock				
		Major species group			
	(In thousand cubic feet)				
National forest	40,376	11,662	6,909	13,776	8,029
Other federal	1,123	30	602	70	421
State	55,058	13,910	5,949	26,751	8,448
County and municipal	4,090	1,268	75	1,982	765
Indian	-	-	-	-	-
Forest industry	35,464	2,170	8,218	11,475	13,601
Individual	101,068	7,959	10,041	50,160	32,908
Corporate	37,137	3,536	3,806	14,307	15,488
All ownerships	274,316	40,535	35,600	118,521	79,660
	Average net annual growth of sawtimber				
		Major species group			
	(In thousand board feet) [1]				
National forest	350,351	127,726	52,891	82,241	87,493
Other federal	8,146	2,044	1,617	2,417	2,068
State	479,807	132,922	76,167	158,312	112,406
County and municipal	39,930	9,517	3,848	12,635	13,930
Indian	1,605	-	306	601	698
Forest industry	184,360	11,089	54,246	48,708	70,317
Individual	1,303,738	153,992	134,221	534,819	480,706
Corporate	297,251	34,934	52,277	104,289	105,751
All ownerships	2,665,188	472,224	375,573	944,022	873,369

[1]International 1/4-inch rule.

Ownership class	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods
	Average annual removals of sawtimber				
		Major species group			
	(In thousand board feet) [1]				
National forest	86,497	22,247	17,993	24,499	21,758
Other federal	3,991	167	1,958	286	1,580
State	119,293	41,006	14,861	45,980	17,446
County and municipal	10,044	3,095	284	5,101	1,564
Indian	-	-	-	-	-
Forest industry	126,529	10,684	28,430	29,424	57,991
Individual	306,054	30,043	22,883	135,014	118,114
Corporate	124,113	15,015	14,134	33,236	61,728
All ownerships	776,521	122,257	100,543	273,540	280,181

[1]International 1/4-inch rule.

Table 25. -- Average net annual growth and average annual removals of growing stock and sawtimber on timberland by forest type group/local type and major species group, Michigan, 1980-1992.

Forest type group/ local type	Average net annual growth of growing stock					Average annual removals of growing stock				
		Major species group					Major species group			
	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods
	(In thousand cubic feet)					(In thousand cubic feet)				
Softwood type groups										
White-red-jack pine										
Jack pine	22,785	18,777	876	1,919	1,213	6,930	5,841	64	703	322
Red pine	73,594	67,521	1,032	3,057	1,984	23,498	18,250	729	3,012	1,507
White pine	11,962	9,515	332	1,365	750	3,630	2,729	202	457	242
Total	108,341	95,813	2,240	6,341	3,947	34,058	26,820	995	4,172	2,071
Spruce-fir										
Balsam fir	17,032	1,768	10,336	4,479	449	6,177	230	4,566	1,338	43
White spruce	7,565	717	5,352	1,371	125	342	105	35	179	23
Black spruce	9,532	1,529	6,601	1,375	27	2,026	410	969	647	-
Northern white-ced	32,471	1,721	29,270	1,096	384	7,691	260	6,450	787	194
Tamarack	2,753	75	2,335	323	20	453	23	347	83	-
Total	69,353	5,810	53,894	8,644	1,005	16,689	1,028	12,367	3,034	260
All softwood types	177,694	101,623	56,134	14,985	4,952	50,747	27,848	13,362	7,206	2,331
Hardwood type groups										
Oak-hickory										
Oak-hickory	79,079	5,907	723	18,333	54,116	19,426	1,877	14	4,742	12,793
Elm-ash-cottonwood										
Elm-ash-soft maple	61,290	851	5,160	42,184	13,095	12,961	438	1,183	9,954	1,386
Maple-beech-birch										
Maple-beech-birch	315,925	12,855	21,801	117,137	164,132	119,529	5,953	9,147	48,738	55,691
Aspen-birch										
Aspen	109,888	6,478	11,567	81,276	10,567	68,317	3,959	10,785	46,188	7,385
Paper birch	10,922	839	2,572	6,604	907	1,476	-	439	975	62
Balsam poplar	5,467	43	1,521	3,809	94	1,212	-	497	703	12
Total	126,277	7,360	15,660	91,689	11,568	71,005	3,959	11,721	47,866	7,459
All hardwood types	582,571	26,973	43,344	269,343	242,911	222,921	12,227	22,065	111,300	77,329
Nonstocked	150	92	46	12	-	648	460	173	15	-
All forest types	760,415	128,688	99,524	284,340	247,863	274,316	40,535	35,600	118,521	79,660

Forest type group/ local type	Average net annual growth of sawtimber					Average annual removals of sawtimber				
		Major species group					Major species group			
	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods	All species	Pine	Other softwoods	Soft hardwoods	Hard hardwoods
	(In thousand board feet) [1]					(In thousand board feet) [1]				
Softwood type groups										
White-red-jack pine										
Jack pine	77,507	68,220	1,201	3,558	4,528	12,604	11,346	59	601	598
Red pine	226,704	206,801	4,917	7,034	7,952	53,044	43,250	2,714	4,322	2,758
White pine	58,295	48,218	2,630	3,512	3,935	14,752	13,104	340	459	849
Total	362,506	323,239	8,748	14,104	16,415	80,400	67,700	3,113	5,382	4,205
Spruce-fir										
Balsam fir	61,461	9,526	39,050	11,967	918	16,240	1,106	12,868	2,215	51
White spruce	18,702	3,469	11,699	3,267	267	863	613	140	61	49
Black spruce	25,662	7,025	16,801	1,870	-34	6,215	1,895	2,913	1,407	-
Northern white-ced	110,452	9,646	92,229	7,403	1,174	18,108	1,336	14,490	1,433	849
Tamarack	8,539	610	7,455	442	32	902	113	638	151	-
Total	224,816	30,276	167,234	24,949	2,357	42,328	5,063	31,049	5,267	949
All softwood types	587,322	353,515	175,982	39,053	18,772	122,728	72,763	34,162	10,649	5,154
Hardwood type groups										
Oak-hickory										
Oak-hickory	327,425	22,455	1,265	58,149	245,556	53,617	4,159	70	10,499	38,889
Elm-ash-cottonwood										
Elm-ash-soft maple	205,626	5,703	22,492	137,185	40,246	34,649	2,120	2,262	25,845	4,422
Maple-beech-birch										
Maple-beech-birch	1,116,031	59,436	112,661	407,852	536,082	421,173	28,587	36,661	137,542	218,383
Aspen-birch										
Aspen	370,156	26,947	45,923	267,625	29,661	137,760	13,200	25,774	85,656	13,130
Paper birch	37,340	3,286	9,958	21,466	2,630	2,173	-	419	1,599	155
Balsam poplar	20,589	216	7,259	12,692	422	2,904	-	1,106	1,750	48
Total	428,085	30,449	63,140	301,783	32,713	142,837	13,200	27,299	89,005	13,333
All hardwood types	2,077,167	118,043	199,558	904,969	854,597	652,276	48,066	66,292	262,891	275,027
Nonstocked	699	666	33	-	-	1,517	1,428	89	-	-
All forest types	2,665,188	472,224	375,573	944,022	873,369	776,521	122,257	100,543	273,540	280,181

[1]International 1/4-inch rule.

Table 26. -- All live aboveground tree biomass on timberland by ownership class, major species group, and tree biomass component, Michigan, 1993

(In green tons)

Ownership class and major species group	All components	Tree biomass component						
		All live 1-5 inch trees	Growing-stock trees			Non-growing-stock trees		
			Stumps	Boles	Tops and limbs	Stumps	Boles	Tops and limbs
National forest								
Pine	33,166,395	4,057,053	1,697,879	23,750,128	2,829,215	50,618	699,250	82,252
Other softwoods	31,725,021	7,490,759	1,617,850	15,658,354	4,326,066	202,683	1,936,080	493,229
Soft hardwoods	61,722,187	8,595,693	2,281,452	32,339,679	9,990,451	427,067	6,271,615	1,816,230
Hard hardwoods	68,959,852	5,877,217	2,960,162	38,150,956	12,121,886	552,942	7,114,945	2,181,744
Total	195,573,455	26,020,722	8,557,343	109,899,117	29,267,618	1,233,310	16,021,890	4,573,455
Other federal								
Pine	697,252	98,361	36,282	481,701	57,421	1,424	19,850	2,213
Other softwoods	553,270	92,975	28,169	310,221	84,990	2,439	27,339	7,137
Soft hardwoods	1,482,982	140,164	57,530	867,229	252,758	7,204	125,906	32,191
Hard hardwoods	1,120,189	37,787	50,367	664,981	210,978	8,169	114,845	33,062
Total	3,853,693	369,287	172,348	2,324,132	606,147	19,236	287,940	74,603
State								
Pine	35,212,903	3,859,747	1,734,974	25,135,734	2,926,029	94,527	1,308,133	153,759
Other softwoods	49,407,879	12,395,945	2,679,655	23,717,139	6,800,689	328,682	2,742,796	742,973
Soft hardwoods	104,233,645	16,262,831	3,920,403	55,901,385	17,027,775	564,770	8,165,299	2,391,182
Hard hardwoods	79,275,473	6,759,179	3,579,188	45,762,758	14,604,029	481,432	6,224,716	1,864,171
Total	268,129,900	39,277,702	11,914,220	150,517,016	41,358,522	1,469,411	18,440,944	5,152,085
County and municipal								
Pine	2,521,375	258,567	126,476	1,814,391	226,273	5,772	79,187	10,709
Other softwoods	2,095,851	391,316	114,107	1,087,475	294,787	17,107	153,042	38,017
Soft hardwoods	7,341,616	950,807	277,135	4,019,124	1,210,168	42,963	664,794	176,625
Hard hardwoods	8,986,904	607,687	391,601	5,217,101	1,620,462	63,185	839,320	247,548
Total	20,945,746	2,208,377	909,319	12,138,091	3,351,690	129,027	1,736,343	472,899

(Table 26 continued on next page)

(Table 26 continued)

		Tree biomass component						
	All components	All live 1-5 inch trees	Growing-stock trees			Non-growing-stock trees		
			Stumps	Boles	Tops and limbs	Stumps	Boles	Tops and limbs
Indian								
Pine	-	-	-	-	-	-	-	-
Other softwoods	259,710	91,647	11,396	122,330	31,264	217	2,351	505
Soft hardwoods	555,687	30,724	25,420	342,723	106,761	2,626	36,942	10,491
Hard hardwoods	687,419	51,604	30,436	414,989	132,055	3,949	38,901	15,485
Total	1,502,816	173,975	67,252	880,042	270,080	6,792	78,194	26,481
Forest industry								
Pine	2,504,635	125,897	117,392	1,960,230	210,230	4,835	77,649	8,402
Other softwoods	34,655,825	6,908,954	1,848,241	17,763,056	4,823,809	265,893	2,423,839	622,033
Soft hardwoods	38,483,306	4,884,741	1,485,699	20,455,727	6,338,995	271,572	3,902,324	1,144,248
Hard hardwoods	63,386,514	6,163,255	2,591,706	34,473,414	10,858,835	521,792	6,718,479	2,059,033
Total	139,030,280	18,082,847	6,043,038	74,652,427	22,231,869	1,064,092	13,122,291	3,833,716
Individual								
Pine	39,111,019	4,444,323	1,957,844	26,717,053	3,602,435	149,531	1,922,652	317,181
Other softwoods	78,165,748	20,813,252	4,068,337	37,007,653	10,533,923	475,439	4,146,361	1,120,783
Soft hardwoods	290,971,029	31,034,103	11,512,510	167,463,506	50,185,752	1,526,617	22,785,321	6,463,220
Hard hardwoods	282,298,494	23,992,792	12,178,382	164,101,087	50,846,898	1,692,746	22,772,887	6,713,702
Total	690,546,290	80,284,470	29,717,073	395,289,299	115,169,008	3,844,333	51,627,221	14,614,886
Corporate								
Pine	9,867,831	844,851	470,950	7,225,863	845,654	27,590	401,995	50,928
Other softwoods	29,047,959	6,196,775	1,505,141	14,801,216	4,033,792	189,513	1,856,502	465,020
Soft hardwoods	64,143,047	6,883,790	2,515,487	36,302,499	10,984,850	371,813	5,523,383	1,561,225
Hard hardwoods	72,303,458	6,206,508	3,050,224	40,886,930	12,764,958	517,941	6,811,597	2,065,300
Total	175,362,295	20,131,924	7,541,802	99,216,508	28,629,254	1,106,857	14,593,477	4,142,473
All ownerships								
Pine	123,081,410	13,688,799	6,141,797	87,085,100	10,697,257	334,297	4,508,716	625,444
Other softwoods	225,911,263	54,381,623	11,872,896	110,467,444	30,929,320	1,481,973	13,288,310	3,489,697
Soft hardwoods	568,933,499	68,782,853	22,075,636	317,691,872	96,097,510	3,214,632	47,475,584	13,595,412
Hard hardwoods	577,018,303	49,696,029	24,832,066	329,672,216	103,160,101	3,842,156	50,635,690	15,180,045
Total	1,494,944,475	186,549,304	64,922,395	844,916,632	240,884,188	8,873,058	115,908,300	32,890,598

Table 27.--Removals[1], net annual growth, inventory, and mortality of growing stock on timberland, Michigan, 1993, and low removals option projections[2] to 2023

(In million cubic feet)

Year	Removals			Growth			Inventory			Mortality[3]		
	All species	Softwoods	Hardwoods	All species	Softwoods	Hardwoods	All species	Softwoods	Hardwoods	All species	Softwoods	Hardwoods
1993	360.5	84.6	275.9	825.0	249.0	576.0	26,644.9	7,572.1	19,072.8	200.4	58.1	142.3
2003	423.6	103.4	320.2	974.4	305.7	668.7	31,460.8	9,319.8	22,141.0	243.3	77.2	166.1
2013	498.9	127.3	371.6	1,152.4	376.2	776.2	37,171.7	11,470.3	25,701.4	295.0	102.2	192.8
2023	588.1	156.7	431.4	1,364.0	463.0	901.0	43,949.3	14,116.3	29,833.0	359.9	136.2	223.7

[1] Timber removals include volume "lost" due to land clearing, flooding, thinning, or changes in land use, in addition to timber cut and used.

[2] Based on the following assumptions: (a) that the area of timberland will decline from 18.6 million acres in 1993 to 18.2 acres in 2023; (b) that 1992 growth rates for softwoods (3.28 percent of inventory) and hardwoods (3.02 percent) will remain constant throughout the projection period; and (c) that 1992 removals rates for softwoods (1.11 percent) and for hardwoods (1.45 percent) will remain constant throughout the projection period.

[3] Mortality has been subtracted from gross growth to yield net annual growth.

Table 28.--Removals[1], net annual growth, inventory, and mortality of growing stock on timberland, Michigan, 1993, and high removals option projections[2] to 2023

(In million cubic feet)

	Removals			Growth			Inventory			Mortality [3]		
Year	All species	Softwoods	Hardwoods	All species	Softwoods	Hardwoods	All species	Softwoods	Hardwoods	All species	Softwoods	Hardwoods
1993	360.5	84.6	275.9	825.0	249.0	576.0	26,644.9	7,572.1	19,072.8	200.4	58.1	142.3
2003	539.8	147.2	392.6	977.1	304.9	672.2	31,000.3	9,141.1	21,859.2	206.1	61.4	144.7
2013	744.7	222.8	521.9	1,117.4	357.4	760.0	34,877.6	10,557.3	24,320.3	203.1	61.6	141.5
2023	960.0	304.4	655.6	1,234.5	400.6	833.9	37,927.7	11,662.5	26,265.2	189.5	57.6	131.9

[1] Timber removals include volume "lost" due to land clearing, flooding, thinning, or changes in land use, in addition to timber cut and used.

[2] Based on the following assumptions: (a) that the area of timberland will decline from 18.6 million acres in 1993 to 18.2 million acres in 2023; (b) that growth rates will increase in a straight line for softwoods from 3.28 percent of inventory in 1992 to 3.44 percent in 2023 and growth rates for hardwoods will increase in a straight line from 3.02 percent in 1992 to 3.17 percent in 2023; (c) that removals will increase in a straight line for softwoods from 1.11 percent in 1992 to 2.61 percent in 2023 and for hardwoods from 1.45 percent in 1992 to 2.50 percent in 2023.

[3] Mortality has been subtracted from gross growth to yield net annual growth.

Table 29. -- Sampling errors[1] for Forest Survey Unit and county totals of area of timberland, volume, average net annual growth, and average annual removals on timberland, Michigan, 1993

(Sampling error in percent)

Forest Survey Unit and county	Area	Growing stock			Sawtimber		
		Volume	Average net annual growth	Average annual removals	Volume	Average net annual growth	Average annual removals
Eastern Upper Peninsula							
Alger	2.05	3.37	5.39	16.63	4.63	6.10	16.07
Chippewa	1.67	3.11	4.91	17.67	4.72	5.55	21.52
Delta	1.82	3.42	5.14	17.89	5.45	5.82	21.41
Luce	2.06	3.70	6.28	19.44	5.09	7.11	18.50
Mackinac	1.94	3.55	5.74	20.72	5.43	6.49	26.93
Menominee	1.94	3.71	5.36	20.22	6.24	6.06	26.94
Schoolcraft	1.94	3.72	5.64	20.58	5.41	6.38	22.77
Total	0.72	1.32	2.06	7.12	1.97	2.33	7.95
Western Upper Peninsula							
Baraga	1.66	3.05	5.00	20.62	4.10	4.43	21.86
Dickinson	1.83	3.71	5.32	34.66	5.81	4.90	70.96
Gogebic	1.48	2.88	4.33	27.29	4.21	4.04	31.88
Houghton	1.59	2.95	4.45	25.00	4.14	4.01	28.24
Iron	1.43	2.96	4.41	17.95	4.30	3.92	21.43
Keweenaw	2.60	4.93	8.60	54.39	6.89	7.57	66.03
Marquette	1.15	2.24	3.34	14.25	3.18	3.10	16.67
Ontonagon	1.38	2.70	4.03	20.16	3.87	3.70	24.42
Total	0.54	1.05	1.59	7.68	1.50	1.45	9.05
Northern Lower Peninsula							
Alcona	2.18	5.24	7.12	34.26	6.82	7.63	39.80
Alpena	2.56	6.60	8.68	32.25	8.90	10.70	40.11
Antrim	2.84	6.32	7.95	48.67	8.87	9.91	53.76
Arenac	3.55	9.60	11.89	68.90	12.74	12.85	86.81
Bay	5.94	15.44	18.11	73.59	21.29	18.39	85.52
Benzie	3.34	7.70	9.21	39.57	10.20	11.13	40.88
Charlevoix	2.99	5.98	8.62	33.50	7.58	9.60	37.74
Cheboygan	2.12	5.54	6.98	40.38	7.58	8.66	57.02
Clare	2.49	6.40	8.10	39.41	8.52	9.42	41.71
Crawford	2.29	6.63	8.72	37.19	9.08	9.81	56.90
Emmet	2.78	6.01	7.85	34.80	8.10	8.99	37.80
Gladwin	2.86	7.96	9.49	40.64	10.91	11.33	45.11
Grand Traverse	2.99	7.00	8.63	68.43	9.88	11.66	85.96
Iosco	2.51	6.53	8.64	45.68	8.57	9.16	49.86
Isabella	3.88	9.69	11.55	108.80	12.11	12.46	136.40
Kalkaska	2.39	5.98	7.14	43.02	8.61	9.44	42.09
Lake	2.20	5.51	6.99	28.85	6.89	7.71	40.24
Leelanau	4.16	8.72	10.74	64.27	10.85	12.52	60.36
Manistee	2.48	6.03	7.68	40.33	7.83	9.05	46.05
Mason	3.12	7.55	8.99	45.59	9.91	10.08	56.86
Mecosta	3.06	7.93	8.90	72.43	10.48	11.36	84.10
Midland	2.95	7.62	9.40	57.29	9.90	10.57	91.00
Missaukee	2.58	6.72	7.48	74.30	9.17	10.09	85.33
Montmorency	2.28	6.27	7.94	39.80	8.47	9.51	47.80
Newaygo	2.15	4.97	6.51	26.74	6.08	7.12	29.70
Oceana	2.90	7.41	9.17	43.89	9.60	10.79	44.36
Ogemaw	2.59	6.83	8.13	30.88	9.70	10.46	38.00
Osceola	2.87	7.61	9.26	34.68	9.58	11.16	41.86
Oscoda	2.23	6.56	7.97	31.72	8.29	9.27	42.02
Otsego	2.52	5.95	7.62	32.28	8.58	9.68	36.82
Presque Isle	2.26	5.97	8.17	32.84	8.31	9.84	40.49
Roscommon	2.45	6.16	9.05	39.22	8.02	9.34	43.85
Wexford	2.43	5.69	6.63	31.62	8.12	8.62	43.20
Total	0.46	1.15	1.45	6.89	1.53	1.71	8.14

(Table 29 continued on next page)

(Table 29 continued)

(Sampling error in percent)

Forest Survey Unit and county	Area	Growing stock			Sawtimber		
		Volume	Average net annual growth	Average annual removals	Volume	Average net annual growth	Average annual removals
Southern Lower Peninsula							
Allegan	5.29	8.39	9.70	45.42	10.89	11.13	46.68
Barry	6.70	10.37	12.07	48.78	13.30	13.53	48.86
Berrien	8.63	12.03	13.50	137.86	15.06	15.34	125.98
Branch	9.58	15.16	18.44	126.58	19.66	21.27	160.51
Calhoun	6.72	11.06	12.12	95.55	14.66	14.33	104.60
Cass	8.06	12.34	15.99	164.59	15.61	18.43	321.01
Clinton	9.63	18.66	20.31	-	27.78	24.64	-
Eaton	7.80	13.24	13.34	66.67	18.87	17.76	77.89
Genesee	8.77	16.54	17.92	109.36	21.53	21.88	115.25
Gratiot	10.07	16.83	18.43	64.90	22.71	20.77	63.24
Hillsdale	8.21	15.75	13.92	270.52	20.90	16.95	339.96
Huron	8.80	16.20	16.74	91.86	22.64	19.16	119.90
Ingham	8.97	15.98	16.45	64.99	21.06	19.38	68.38
Ionia	8.18	14.91	14.74	131.63	20.71	20.12	130.36
Jackson	7.79	12.88	15.11	88.43	16.48	17.31	81.93
Kalamazoo	8.16	13.26	14.37	143.53	17.38	19.00	137.47
Kent	5.67	9.80	10.62	56.80	13.06	12.68	64.47
Lapeer	6.76	12.99	12.00	70.45	17.87	15.19	86.27
Lenawee	9.51	14.67	17.33	141.47	19.93	21.38	134.75
Livingston	7.28	12.08	13.22	53.74	14.99	15.58	61.38
Macomb	9.08	19.75	20.82	129.36	26.46	29.19	145.07
Monroe	11.48	17.53	20.42	98.15	22.76	24.83	93.36
Montcalm	6.13	10.45	11.45	35.47	14.07	13.62	41.47
Muskegon	5.59	9.45	11.13	36.50	12.20	12.61	41.63
Oakland	6.70	12.64	13.43	96.00	16.86	17.82	109.61
Ottawa	7.95	13.43	14.41	46.64	17.28	16.98	52.32
Saginaw	7.11	13.30	14.63	93.32	18.59	19.30	203.33
St. Clair	7.99	11.26	12.97	101.49	14.77	15.81	103.49
St. Joseph	8.72	13.99	16.26	88.64	18.13	19.20	86.48
Sanilac	7.91	17.15	16.76	-	27.23	24.07	-
Shiawassee	9.97	14.84	16.58	48.09	18.28	18.46	47.56
Tuscola	6.58	12.65	12.23	48.75	18.61	17.09	63.07
Van Buren	6.39	11.15	12.45	100.34	14.80	14.86	100.84
Washtenaw	7.79	12.90	16.03	66.85	15.69	18.40	86.48
Wayne	12.71	19.77	20.62	97.48	25.43	25.60	106.19
Total	1.29	2.19	2.40	11.85	2.89	2.90	13.07
All counties	0.34	0.67	0.91	4.02	0.94	1.06	4.73

[1]Sampling error is not calculated when the estimated removals is equal to 0.

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The fifth inventory of Michigan's forests reports 36.4 million acres of land, of which 19.3 million acres are forested. This bulletin presents an indepth analysis of the forest resources and contains detailed tables of area, volume, growth, removals, mortality, and ownership.

KEY WORDS: Forest area, timber volume, growth, removals, mortality.

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